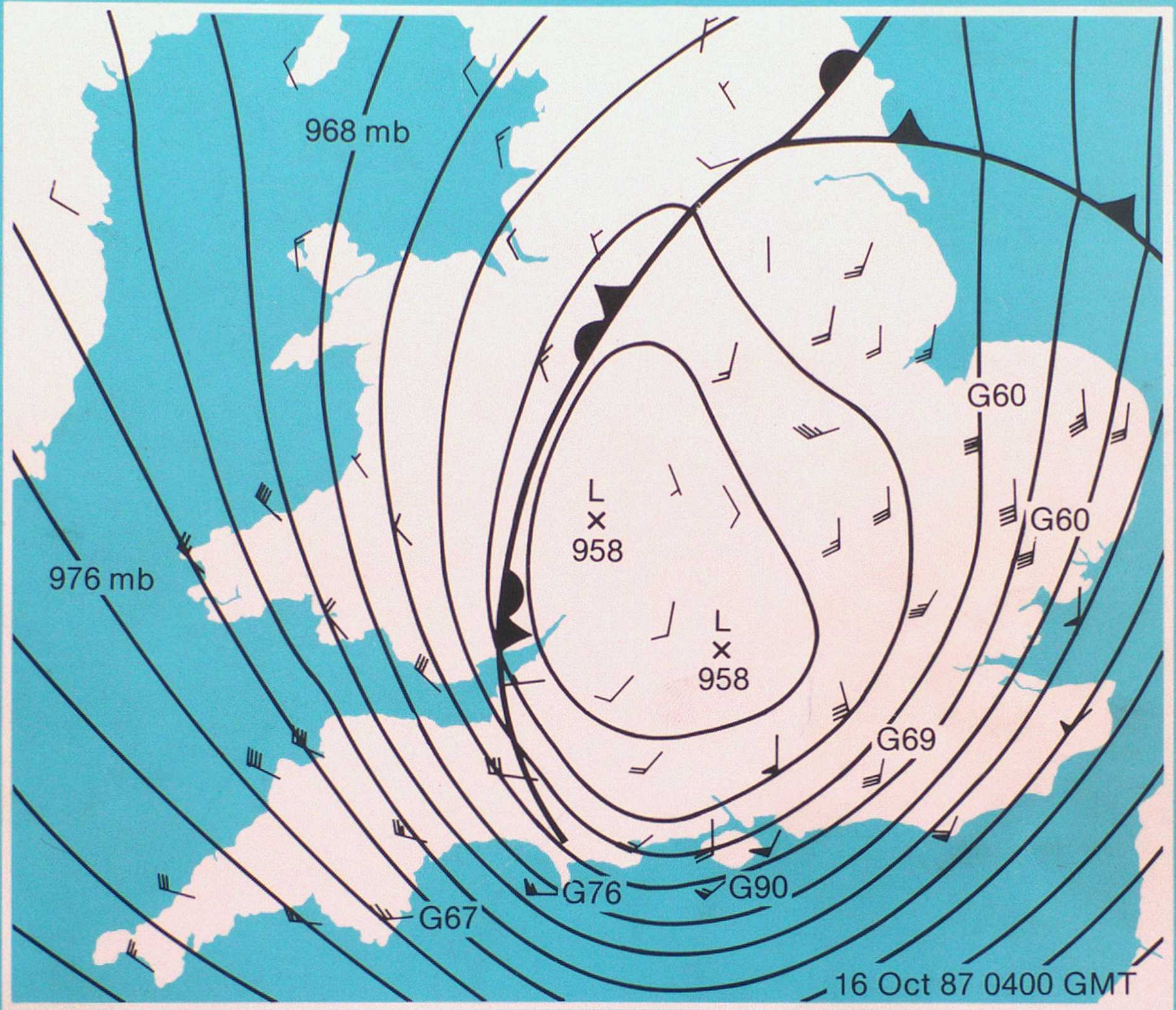
Meteorological Office Report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16 Oct 87 0400 GMT

The Storm of 15/16 October 1987

The storm
of
15/16 October 1987

Meteorological Office
London Road, Bracknell, Berkshire RG12 2SZ

December 1987

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EXECUTIVE SUMMARY

1. The situation leading to the storm of 15/16 October 1987 has been studied in considerable detail. It is clear that several discrete low centres ran north-east over Biscay before the arrival of the final low which developed into the major storm centre. Statistically the falls of pressure in front of the storm were not unusual, but the rise in pressure behind the front was exceptional, with rises of over 20 mb in three hours in places. The belt of southerly gales over land was also exceptional for the south-east in October with expected return periods of over 100 years in some areas.

2. The output from a number of relevant Numerical Weather Prediction (NWP) models was available to the senior forecaster in the Central Forecasting Office in Bracknell. Useful NWP guidance was given in the medium range (3–6 days) but as the time before midnight on 15/16 October became shorter, the various models gave diverging guidance. The 36-hour forecasts from the European Centre for Medium-range Weather Forecasts (ECMWF), the United States and the UK global coarse-mesh model, and the equivalent 24-hour UK fine-mesh forecast, differed substantially; consequently the senior forecasters' guidance depended upon a compromise based on his subjective experience. In the event the emphasis was incorrectly placed on the rain and flooding problems rather than on the possibility of severe gales overland. Thus, although the guidance on the Synoptic Reviews did include gale warnings for exposed parts of southern and eastern England, the main area of severe gales was forecast for the Channel and the southern North Sea and the extreme south-east. The complexity of the situation with which the forecaster had to wrestle is revealed in the full text of the Synoptic Reviews which are included as Annexes to chapter 2.

3. In the scientific investigations that have been carried out in the Meteorological Office following the storm, the main problems of interpretation have arisen from the paucity of data coverage, especially over the ocean areas to the south and west of the United Kingdom. The observations available during 15 October left the actual position of the storm uncertain and fell far short of providing an adequate description of the atmospheric structure in its vicinity. The prerequisites for a really accurate prediction were therefore absent. Although the general synoptic situation at the time of the storm showed conditions that strongly favoured cyclonic development, no features have been identified which would have enabled the quite exceptional character of the storm to be recognized at an early stage. Further, it was the lack of the inclusion of certain observations which were not available at the time of the run of the fine-mesh model following 0000 GMT 15 October that caused that models' prediction to differ from that deduced from the run of the global model following closely after that of the fine-mesh model. The reasons for the poor predictions 12 hours in advance from the numerical model runs at 1200 GMT 15 October have been more difficult to establish. Nevertheless, by introducing features of numerical forecasting systems at an advanced stage of development in the Meteorological Office, it has been possible to obtain good predictions of the track and intensity of the storm by selecting values of the adjustable parameters beginning from 0000, 0600 and 1200 GMT 15 October.

4. The forecasts and warnings concerning the storm given to the public via the Media began the previous Sunday (11 October) when the summary chart of the weeks' weather on the BBC 1 TV programme 'Weather for farmers' included a caption 'becoming very windy late in the week'. On Thursday 15 October from 0630 GMT the shipping forecasts for the Channel and southern North Sea included gale and severe gale warnings. Further warnings of severe weather were given to various authorities from 1730 that evening culminating in a general FLASH message of severe gales at 0120 GMT on 16 October. Customers who could take immediate action on receipt of a warning during the night (e.g. civil and military aviation) received sufficient notice to minimize any damage

that might have been sustained in severe storm conditions. Although strong winds were mentioned especially for the coastal regions in the south and south-east, the Media forecasts on Thursday 15 October emphasized the rain predictions rather than the wind. No forecasts issued by the French, Belgian and Dutch weather services covered the United Kingdom; they were in line with the UK predictions as far as the Channel and the European mainland were concerned.

5. The reaction of the Media in the period following the storm mostly centred on the question 'Why weren't we warned?' Press articles, based on a mistaken interpretation of remarks made to journalists both in the United Kingdom and abroad, were highly critical because they believed incorrectly that other forecasting services 'had got it right'. The TV weathermen (and the Director-General of the Meteorological Office) were put in the spotlight over the weekend, and it was only after the Press Conference given by the Director-General and his Directors on the Monday following the storm that this view subsided, giving way to the more soundly based realization that the damage to trees and property could not have been avoided however accurate the forecasts might have been. Some of the Press confusion revolved around the use of the word 'hurricane' (meteorologically a 'hurricane' is a tropical revolving cyclone); the use of the word by one of the TV weathermen was particularly unfortunate, since it was picked up and exploited by the Media as part of their criticisms.

6. The main recommendations of the Report (which are brought together along with the Reports' conclusions in the last chapter) are that a continuing and enhanced effort is required to improve the observational situation, that developments already under way of higher-resolution models and of a new assimilation scheme for the numerical models should be introduced as early as possible, that the fine-mesh model should be run more frequently and that reviews should be carried out of the warning procedures and of the content and style of the TV presentations.

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Chapter 1

METEOROLOGICAL DESCRIPTION OF THE STORM

1.1 Summary of weather pattern developments

(i) *Introduction*

The sequence of developments will be described by a series of mean-sea-level pressure (PMSL) analyses illustrated by satellite imagery where it is appropriate and convenient to do so (Figures 1.1, 1.2, 1.4 and 1.5). The primary PMSL analyses have been constructed using all sources of information, some of which were not available to the forecasters at the time. The operational PMSL analyses produced by the Central Forecasting Office (CFO), that is those charts drawn within 3 hours of the time of origin of the data, constitute a second series of charts (Figure 1.3) which will be referred to where significant differences are apparent when compared to the finalized analyses. Detailed hourly surface analyses of PMSL are also reproduced (Figure 1.6).

(ii) *0000–0600 GMT 15 October*

Figure 1.1(a), which is almost identical with the CFO operational analysis, shows a complex area of low pressure at 0000 GMT 15 October extending over several hundred miles to the west of Corunna. There were few ship reports to fix the details of the pressure pattern precisely; the analysis therefore depended heavily on the Meteosat imagery (Figure 1.2(a)) and a single ship report giving a northerly wind near 44° N, 13° W.

The Meteosat imagery (Figure 1.2(b)) indicated rapid eastward movement of the main cloud features during the next 6 hours. The finalized surface analysis for 0600 GMT (Figure 1.1(b)) shows the forward low centre near Bordeaux (having degenerated into a minor feature) with a more substantial centre just to the north-west of Corunna. The corresponding CFO operational analysis (Figure 1.3(a)) at first sight appears similar but omits the forward feature, implying only very slow eastward movement of the two low centres. Satellite imagery also suggested a further wave developing on the trailing cold front near 17° W but, with no ship reports in the vicinity, details of this feature cannot be determined with any precision.

A feature of special interest on the satellite imagery is the band of cloud extending west-south-west from around 50° N, 10° W on Figure 1.2(a). This band subsequently took on the appearance of a traditional 'back-bent occlusion' (Figure 1.2(c)) with both medium and high cloud later being reported as it moved over Ireland. Whilst this feature may be of significance in explaining subsequent events, there appears no justification either on evolutionary grounds or from the upper-air patterns for interpreting it on the analyses as the consequence of an occlusion process.

(iii) *1200 GMT 15 October*

At 1200 GMT 15 October (Figure 1.1(c)), the position of the surface trough just to the south-west of Brittany was fixed reasonably well by the ship reports available at the time of the operational analysis but further west the position and depth of the individual low centres were not determined very precisely. However, both the satellite imagery (Figure 1.2(c)) and the complete set of ship reports suggest that the main low centre was probably north-west of Corunna, estimated depth 968 mb, but the exact details of the analysis to the west of the centre were unclear. Comparison with the CFO operational analysis (Figure 1.3(b)) reveals minor differences, the latter analysing an elongated low centre slightly further north-east, central pressure 970 mb. Pressure gradients were very strong on the south-eastern flank of this low and ahead of the trailing cold front, consistent with several reports of winds of 45–55 kn in that sector. The Meteosat image also shows signs of a further low pressure centre on the cold front near 42° N, 15° W; by following the imagery through it appears that this feature ran rapidly north-east and was associated with the development of the storm centre. This feature is most clearly shown on the NOAA AVHRR imagery. At 0841 GMT (Figure 1.4(a)) it is located near 42° N, 18° W, moving to around 44° N, 11° W by 1447 GMT (Figures 1.4(b) and 1.4(c)).

(iv) *1800 GMT 15 October*

By 1800 GMT, the surface observations (Figure 1.1(d)) indicate that this low pressure centre was developing into a vigorous centre near 45° N, 8° W with winds of 60 kn ahead of the cold front. The CFO operational analysis (Figure 1.3(c)) did not define the two separate centres over Biscay but again showed a single elongated centre, probably the best that can be expected given the time available for the analysis. Nevertheless the very strong gradients ahead of the cold front were well represented in the drawing. It should be borne in mind that the 1800 GMT senior forecaster's working chart as shown becomes available for analysis between 2000 GMT and 2045 GMT (i.e. between 2100–2145 BST), the interval between observation time and analysis time occurs because the observations must be collected from all over Europe and the North Atlantic area after they are made and plotted onto the charts, the time being minimized by automation, to the extent possible, of the communication, decoding and plotting functions.

The selected ship with call sign GUMM which was also near 45° N, 8° W at 1800 GMT has subsequently provided evidence confirming the position of the cold front deduced from satellite imagery. Although the surface pressure reports from the vessel consistently appear about 3 mb too high in relation to surrounding data, the barograph trace received well after the event shows a marked pressure minimum at 1800 GMT with a fall of about 12 mb in the preceding 3 hours. All the evidence suggests that the low centre passed just north-west of the ship at that time. It should also be noted that there is evidence, from the various wind reports, of a marked trough developing in the cold air behind the front.

(v) *2100 GMT 15 October*

The surface analysis at 2100 GMT is reproduced in Figure 1.1(e). Although there are no ship observations in Biscay to help with the analysis the sequence of Meteosat images from the HERMES system (Figure 1.5) shows a marked circulation developing in the cold air to the south-west of Brittany at this time. This effect can be seen in Figure 1.2(e) where the eastern edge of the cloud band south of Ireland (i.e. the cloud band referred to in subsection (ii)) has now acquired a marked cyclonic curvature on its south-eastern edge. By this time strong gusts of 72 kn were being reported over Brittany ahead of the approaching cold front. Thus, although a forward low centre was evident over the western English Channel, as depicted in the UK surface analysis at the time, the main storm centre was still south-west of Brest.

(vi) *0000 GMT 16 October*

The finalized surface analysis for 0000 GMT 16 October is shown in Figure 1.1(f), the storm centre now being analysed in the south of sea area Plymouth, estimated depth 952 mb. This is slightly further south and 8 mb deeper than the CFO operational analysis (Figure 1.3(d)), the difference arising because the crucial observations from Ushant and Ile de Batz were not received in CFO for the operational analysis. Observations at this time indicated that winds had reached 45–55 kn in the western and southern sectors of the depression and there were reports of 45–50 kn also along the English Channel to the east of the centre. Winds reached gale force along parts of the south coast at about this time. However the lack of observations from Brittany meant that the forecasters were unaware of the exceptional gust of 95 kn recorded on the north French coast at that time.

A notable feature of the analysis in Figure 1.1(f) is the exceptional pressure gradient drawn to the south of the centre with geostrophic gradients exceeding 300 kn in the strongest zone. This analysis hinges on the report from the ship at 48° N, 6° W (call sign VSBP). Although the pressure characteristic is clearly wrong (a *rise* of 13 mb would fit with the 2100 GMT analysis) the ship does not appear on the CFO list of unreliable ships. Later observations from the ship appeared satisfactory and with geostrophic gradients of well over 200 kn evident in the English Channel a few hours later, it seems likely that the drawing is not too far from the truth.

(vii) *Hourly surface analyses*

The detailed hourly surface analyses over southern Britain and the English Channel are reproduced in Figure 1.6 for the period 0000 to 0600 GMT 16 October. It can be seen that as the storm approached the English coast, two separate centres became apparent with relatively light winds in the vicinity of these centres and to the north of them. The very strong winds lay in a belt through the eastern, southern and western quarters, the highest and most damaging gusts being experienced around 0500 GMT some 200 miles or so to the south-east of the centre. Some of those most affected by the gales noticed that their barometers had fallen off the scale on the stormy side and wondered why the forecasters had not noticed it too. But the crux of the forecasting problem was not simply that the forecasting of pressure would be very low, it was already low over the British Isles on the 15th and expected to go lower over southern England. In many areas of northern England and the Midlands, where barometers were low, there were no gales at all. The problem was not only that of forecasting the depression track, although that was relevant. The crux of the problem was the prediction of the location and severity of the belt of very strong winds and that problem had exercised the forecasters' minds from Sunday 11 October onwards.

(viii) *Summary*

A detailed 'after the event' appraisal of all the data and satellite imagery indicates that several discrete low centres ran rapidly north-east over Biscay before the arrival of the final low which was associated with the major storm development. Tracking of the centre depicted on the CFO operational analyses (Figure 1.7(a)) suggests slow north-eastward transference of the low across southern Biscay up to 1800 GMT 15 October, followed by a rapid acceleration towards the United Kingdom. In reality it was different low centres which were being followed and this explains the inconsistent movement. In contrast the deduced track and depth of the developing low centre present a very coherent pattern (Figure 1.7(b)). The chart reveals relatively steady deepening of the centre as it tracked from west of Iberia to the western English Channel (allowing for the inherent uncertainties in the analysis).

1.2 A detailed description of wind and weather during the passage of the storm across southern England

(i) *Introduction*

This section contains a more detailed description of the wind, pressure and temperature experienced at individual locations in southern England during the passage of the storm on the night of 15/16 October 1987. The extreme values of wind and pressure experienced are also put into perspective by comparison with historical events.

(ii) *Temperature*

On the evening of the 15 October a frontal zone was moving across south-east England. To the south of the frontal zone the air was mild with temperatures between 14°C and 17°C, and the wind direction southerly to south-westerly. To the north of the frontal zone the air was much cooler, between 5°C and 7°C, and the winds were blowing from the north-east.

As the warm air advanced across the country there were large changes in temperature, with rises of about 5°C at Plymouth just before midnight and rises of about 10°C farther to the east. The temperature changes are clearly illustrated by the thermogram given in Figure 1.8. An analysis of the rates of changes of air temperature over various time scales based on 15 years of data (see *Climatological Memorandum No. 111* from the Meteorological Office) gives extreme hourly changes in one hour of 5.6°C in London on 13 April 1969, in a showery airstream and 6.6°C at

Boscombe Down on 16 March 1972, with a ridge of high pressure across the country, the temperature rise occurring after a clear night. The rises in temperature in the early hours of 16 October 1987 greatly exceeded these previous extremes and were unusual in that they were associated with a front.

Between 0100 and 0200 GMT the temperature at Heathrow rose by over 7°C compared with the previous highest rise in 1 hour, taken from hourly observations over 37 years of record, of 6.7°C; this was associated with strong solar heating on 26 March 1963. The previous highest frontal rise was 6.1°C on 9 October 1951, 16 October 1952 and 7 November 1956. A preliminary study of previous rises shows that a rise of over 7°C in 1 hour at Heathrow is a very rare occurrence.

(iii) *Pressure changes in south-west England*

Some hourly pressure changes in south-west England at the start of the storm are tabulated in Table 1.1. This shows that the falls of pressure, before the front went through and ahead of the storm centre, were by no means unusually steep and looked no different on the barograph from many other pressure falls preceding strong gale or storm force winds. However, the rise in pressure after the passage of the front was phenomenal, with around 20 mb rises in three hours in a number of places. Figure 1.9 shows a typical barograph trace. It can be seen that the pressure fall on the previous day (0900–2200 GMT on 14 October) was greater than the fall on 15 October and more rapid.

The highest and steepest rises in the three hours to 0600 GMT were in parts of central southern England, ranging from 19.5 mb at Bristol to 25.4 mb at RNAS Portland which is believed to be the greatest rise of pressure in three hours on record for the British isles. The rises in the three hours to 0900 GMT in more easterly parts of England were steep, but not quite as steep as those in southern areas, although in most of East Anglia pressure rose more than 19.2 mb, the highest rise being 20.0 mb at Wittering at 0900 GMT. The three-hourly pressure changes at 0000, 0300, 0600 and 0900 GMT are shown, together with the gusts, in Figure 1.10.

(iv) *Pressure changes elsewhere*

Hourly pressure rises seem to have been exceptional. A large area of southern England experienced rises in excess of 8 mb in 1 hour, with a maximum value of 12.2 mb at Hurn. The previous highest hourly rise in the period from 1957 to date was 6.9 mb at Eskdalemuir on 8 December 1964. On 2 January 1976 rises of 6.0 and 6.7 mb were recorded over successive hours at Eskdalemuir. Analysis of the hourly pressure changes from many stations in the recent storm shows a ratio of about 1.3 between those stations where the maximum rise occurred between hourly reports and those where it occurred close to the hour and so gave two similar (smaller) rises over 2 hours. Applying this ratio to the two values from Eskdalemuir for January 1976, gives an estimated maximum hourly rise of 8.3 mb. Also, for that occasion, Shaw *et al.* (*Weather*, June 1976) found a maximum pressure rise of 8.2 mb at Prestwick. This figure, which is probably the previous highest hourly change over the last 30 years over most of the United Kingdom, is only two-thirds of the maximum value for 16 October 1987. A preliminary analysis of previous pressure rises at Eskdalemuir gives a return period of about 500 years for an hourly rise in excess of 12 mb.

(v) *Wind observations*

For most weather forecasting purposes the wind is reported at hourly intervals usually using indicating-dial anemometers. The observer takes at least two readings of mean wind speed (each reading being over 15 seconds) within the overall period of the observation (approximately 10 minutes) and should report the average of these readings. A wind thus reported is usually referred to as a 10-minute wind.

Stations equipped with anemometers and a dial also report the highest gust in the previous hour using an anemograph trace if available. At main (0000, 0600, 1200, 1800 GMT) or intermediate (0300, 0900, 1500, 2100 GMT) hours the highest gust in the previous 6 or 3 hours respectively is reported in the routine synoptic report.

When there is no anemometer the strength of the wind has to be estimated, usually in terms of Beaufort Forces, from its affect on surrounding objects such as trees or water surfaces, and by means of the experience of the observer. In such cases it is not usually possible to produce a reliable estimate of a gust speed by visual means. Estimates of wind speed for such extremes as occurred on 16 October are unreliable.

For climatological purposes, continuous anemograph traces (see Figure 1.11 for an example) are analysed to produce the mean wind speed and direction for each hour, together with the maximum gust speed for that hour. The values are tabulated, with the direction and time of the highest gust each day, to build up a record of the hourly wind for the month. At a number of stations the chart recording system is enhanced by a digital logging system.

A gale is defined as a wind of 34 kn mean speed lasting at least 10 minutes. For purposes of issuing gale warnings the term is also used for gusts to 43 kn or more, even though the mean speed may be less than 34 kn, (isolated gusts accompanying squalls or thunderstorms do not qualify as gales).

(vi) *Surface winds on 15/16 October 1987*

Details of the surface winds as reported by observing sites are shown in Figure 1.12. These reports form part of the full weather observation made in the 10 minutes or so before the nominal hour of observation shown on the charts. Therefore the mean wind direction and speed refer to a 10-minute period preceding the time shown.

At 2100 GMT on 15 October most of southern England except the coasts of Kent and Sussex was covered by light to moderate north-easterly winds. Observers around the coasts of Kent and Sussex were already reporting stronger winds from the south or south-west.

By 0000 GMT the stronger winds had spread quickly northwards over southern England, backing to south-south-east to south. Gusts to more than 40 kn were reported over some inland areas and gusts to over 70 kn occurred at a number of coastal stations.

Between 0200 GMT and 0600 GMT, most areas experienced their strongest winds (see Figures 1.12(d) to 1.12(h)). Particularly noteworthy are the gusts of 80 to 90 kn shown on the charts for the hours ending 0400 GMT to 0600 GMT over the area south of an approximate line from London to the Isle of Wight. Gusts to 82 kn were recorded in London between 0200 GMT and 0300 GMT, but stations along the coast and in the Thames Estuary recorded gusts exceeding 90 kn at times, especially between 0300 GMT and 0500 GMT.

By 0600 GMT most of England south of a line from Bristol to the Wash was covered by a broad belt of very strong winds. The wind direction had veered to south-west or west by this time as the depression moved away across Humberside. By 0900 GMT the winds had moderated over most areas except northern parts of East Anglia.

In the region of most damage, roughly south of a line from Southampton to Ipswich, maximum gusts occurred about 0300 GMT and 0600 GMT. Gusts of 70 kn or more were reported for three or four consecutive hours during which time the mean wind veered from 180° to 230°. To the north-west there were two periods of high gust speed separated by a clear drop in wind speed. The first peak was associated with mean winds from between 170° and 190°, the second with a direction of around 230°. Strongest gusts were mostly in the southerlies between 0200 GMT (over central southern England) and 0400 GMT (over East Anglia). Over Dorset and Somerset and north of a line from Bath to Norwich the west to south-west winds were strongest, with maximum gusts around 0500 GMT in the west and 0800 GMT in the east. A separate area of strong northerly winds affected Cornwall from midnight to about 0200 GMT.

(vii) *Gust Ratios*

The ratio of the maximum gust to the hourly mean speed at the hour in which the gust occurred is used as an index of the gustiness of the wind. At an inland rural site, free from obstruction and at 10 m above the ground, a typical value of the gust ratio in strong winds is about 1.6 with a standard deviation of 0.10. In the storm of 16 October a number of much higher values of the gust ratio were noted, but in general the ratios were within the range of ratios for the relevant sectors. Table 1.2 shows the gust ratio for each station with gusts of 70 kn or more on the 16 October.

Gust ratios for the mean wind and maximum gust over an hour have been calculated for the severe gales of 27 March 1987 which also affected southern England, for 24 March 1986 when strongest gusts of just over 70 kn occurred in a band through South Wales, the south midlands and East Anglia and for 2 January 1976 when many stations in the south midlands had their highest recorded gusts. When compared with these values, on average the gust ratios for the recent storm are unexceptional (see Table 1.3).

However, some individual stations did produce very high ratios for the extreme gust, notably Bristol Weather Centre (2.9, though gusts did not exceed 70 kn), Southampton (2.5), Gatwick (2.5), and Ashford (2.4). Southampton and Ashford have non-standard exposures. Gust ratios in excess of 2.3 have occurred on several occasions in the past at Gatwick and, since a site change in 1983, mean winds have been considered unrealistically low for southerly directions. This value may, thus, be a consequence of the particular site rather than an indication of the nature of the particular storm. All other ratios in excess of 2.0 occurred in urban areas where such ratios may be expected so that the conclusion remains that the gust ratios were generally within the bounds suggested in the *Forecasters' Reference Book*: 1.5–2.0 for farmland, 1.7–2.1 for highly wooded areas and outskirts of cities, 1.9–2.3 for city centres. The Bristol gust was very isolated and may have been a freak effect.

Because of the possibility of a different stability in the southerly and south-westerly winds, gust ratios were calculated separately for wind directions ≦200° and ≧210°. The mean values of 1.88 and 1.72 respectively are just significantly different at the 5% level. However, there are no data available to help to determine whether or not there was sufficient difference in stability between the southerly and south-westerly airstreams for the higher gust ratio.

(viii) *Frequency of occurrence of wind speeds*

An assessment of how unusual were the wind speeds recorded on 16 October 1987 may be reached using extreme value analyses of the past records from anemograph stations. Estimates of the average frequencies of occurrence ('return periods') of the maximum gust and maximum hourly wind speeds were made for a selection of stations within and bordering on the areas most severely affected. To enable the most reliable estimates to be made, the choice of stations should be restricted to those with long records. However, in order to improve the spatial coverage, it has been necessary to use data from some stations having less than 30 years of record. Any changes in the exposure of the anemographs during the period of analysis were accounted for by correcting all the annual maximum wind speeds used to a common effective height. The results are shown in Table 1.4. The analysis periods used were principally those ending in 1986, but further analyses were carried out for six of the stations using the maximum speeds on 16 October 1987; the influence of the speeds on 16 October resulted in relatively small decreases in return period. The following conclusions may be drawn.

(a) At several stations, including Shoeburyness where continuous records span over 60 years, wind speeds on 16 October exceeded the previous highest recorded.

(b) To the south-east of a line from the coast of East Anglia through southern London to Southampton Water, the return periods of both the maximum gust and the maximum hourly mean speed exceed 200 years.

(c) There is a marked gradient in the distribution of return periods, corresponding to the line mentioned earlier from East Anglia to Southampton, so that to the north-west of London the speeds were much less exceptional, with return periods generally less than 10 years.

The current British Standards Institution Code of Practice for the design of buildings and other structures (CP3, Chapter V, 1972 with amendments 1986) includes advice on wind loading. The corner-stone of this advice is a map of the gust speed having a return period of 50 years for a height of 10 m above open, level terrain. For practical application, adjustments to this 'basic wind speed' are made for height above ground, terrain roughness, topography, cost and safety aspects. An adapted version of the map is given in Figure 1.13; this includes the approximate equivalent

50-year-return-period hourly mean wind speeds, calculated from the gusts using a gust ratio of 1.6. This map confirms that the basic wind speed used by building designers was exceeded over a large area (most of south-eastern England) on 16 October, the first such occasion since the Code of Practice was introduced. It may also be noted that although the speeds given in Table 1.4 are normally very infrequent in south-east England, their associated return periods are much smaller over western and northern areas of the United Kingdom. For example, places to the north-west of a line from Northumberland to Cornwall (and exposed places elsewhere) can expect gusts of 90 kn on average more frequently than once in 50 years.

(ix) *Seasonal and directional factors affecting the frequency*

In view of some of the damage caused to trees in leaf, it is of interest to assess the frequency with which such wind speeds occur in October. It is not statistically sound to analyse the highest speed recorded each October to produce return periods, since there are insufficient data for the analysis techniques used, but some indication of the rarity of the speeds on 16 October may be gained from a ranking of these with previous Octobers. This is done for a selection of stations in Table 1.5. At almost all stations the speeds on 16 October were the highest ever recorded in October. The exception is Jersey, where there were localized very strong winds on 9 October 1964.

The previous highest gust in the last 50 years inland over southern England and East Anglia when trees were likely to have been in leaf was 70 kn at Boscombe Down (24 October 1945). Dover recorded 79 kn on 27 October 1959 and 80 kn on 4 November 1957. The storm which produced a 94 kn gust at Jersey on 9 October 1964 did not affect southern England.

Since the strongest winds in the United Kingdom are usually associated with directions from about 230° to 280°, the occurrence of high hourly mean winds and gusts from directions 170° to 190° appears to be unusual. However, this is not easy to check, since no long records are available of the highest speed per year, analysed for individual wind directions. Hourly records of wind speed and direction have only been held on a computer archive since 1970. Using these data it can be seen that during the period 1971–83 at Heathrow, the hourly mean speed never exceeded 27 kn whilst the mean wind direction was in the sector 170°–190°. On 16 October 1987 the hourly mean speed was at least 36 kn for 3 hours for a direction of 170°.

The States of Jersey Meteorological Service reports that the southerly direction was a major factor in causing more damage, with lower speeds in the recent storm than in some of its predecessors. Winds from between 170° and 220° contributed only 3.3 per cent of mean hourly winds in excess of 33 kn at Jersey (1958–87).

Analyses of periods of strong winds at 50 places in the United Kingdom carried out by the Building Research Establishment suggest that, for a given return period,

(a) the ratio of the extreme in October to that for all the year is generally 0.82, with ratios for December and January close to unity (i.e. the annual maximum wind speeds normally occur in these months), and

(b) the ratio of the extreme for sector 170°–190° to that for all wind directions is generally 0.85, with ratios for 30° sectors centred on 240° and 270° close to unity, i.e. the strongest winds normally occur in these sectors.

Thus, when either the seasonal or the directional feature of the storm on 16 October 1987 is taken into account, the likelihood of having winds of this strength from these directions in October is very much rarer than the return periods of Table 1.4 might suggest.

(x) *A comparison with the gale of 2 January 1976*

Amongst the previous exceptional gales which have raised extensive damage within living memory are those listed in Table 1.6. The gale on the evening of 2 January 1976 was one of the most severe to affect the British Isles this century, with structural damage reported from almost every county of England, Wales and Northern Ireland. At least 23 deaths in the United Kingdom were attributable to the gale. British Rail services were disrupted in the midlands because of the collapse of overhead power supplies; at Liverpool, a landing stage for the Mersey Ferry was sunk and at Southend Airport a light aircraft was blown on to adjacent railway lines and blocked traffic into London. The number of stations on 2 January 1976 recording mean winds of 48 kn or more, or gusts of 72 kn or more, was 40; the highest gust at a low-level station was 91 kn at Wittering, Cambridgeshire.

The number of stations in the main area of the storm recording mean winds of 47 kn or more, or gusts of 70 kn or more, on 16 October 1987 (i.e. approximately south of a line from Bristol to the Humber) was about 26; the highest gusts of the storm were 106 kn at 0424 GMT and 104 kn at 0516 GMT both at Gorleston, Norfolk. The next highest gust was one of an estimated 100 kn at Shoreham by Sea, West Sussex, where unfortunately the power failed at 0400 GMT and was not restored until 0740 GMT, so the exact time of gust is not known; however, the station had two gusts to 98 kn at 0310 and 0330 GMT.

(xi) *Concluding remarks*

There have been many severe storms over the United Kingdom causing extensive damage and with wind strengths comparable to those on 15/16 October 1987. However, winds of the reported strength are extremely rare over south-east England. Furthermore, October is not normally a month of very extreme winds, nor do extreme winds normally occur with directions between 170° and 220°. While return periods, considered on an annual basis, may have been as high as 200 years or more (e.g. Gorleston and Shoeburyness), the probability of winds of these strengths from these directions during October is a considerably rarer (and unquantifiably so) event.

Table 1.1 *Pressure and hourly changes (mb) in the south-west of England on 15/16 October 1987*

Date/Time	Scilly		St Mawgan		Plymouth		Chivenor		Bristol	
15/2100	970.5		971.0		970.0		971.0		972.0	
		−2.2		−5.5		−3.5		−2.0		−2.0
15/2200	968.3		976.6		966.5		969.0		970.0	
		−1.3		−2.5		−3.5		−3.5		−1.9
15/2300	967.0		965.0		963.0		965.5		968.1	
		+0.5		−2.0		−2.0		−5.0		−4.1
16/0000	967.5		963.0		961.0		961.5		964.0	
		+4.5		+1.5		−1.7		−2.0		−2.5
16/0100	972.0		964.5		959.3		959.5		961.5	
		+4.0		+4.0		+3.2		−1.0		−2.0
16/0200	976.0		968.5		962.5		959.8		959.5	
		+3.5		+7.5		+9.5		+1.5		−2.5
16/0300	979.5		976.0		972.0		960.0		957.0	
		+2.5		+4.0		+7.0		+7.0		+1.0
16/0400	982.0		980.0		979.0		967.0		958.0	
		+3.0		+3.0		+3.3		+6.0		+10.0
16/0500	985.0		983.0		982.3		973.0		968.0	
		+1.5		+2.5		+2.2		+4.4		+8.0
16/0600	986.5		985.5		984.5		977.4		976.0	

Table 1.2 *Highest mean wind and gusts, plus the gust ratio, at anemograph stations with gusts of 70 kn or more on 16 October 1987*

Station	Highest mean deg/kn	Time GMT	Highest gust deg/kn	Time GMT	Gust ratio
Boscombe Down	170/37	0100	170/70	0114	1.9
Amersham	180/36	0200	180/73	0225	2.3
Middle Wallop	/48	0100	/78	0122	1.6
Odiham	170/40	0100	180/70	0100	1.7
Heathrow NE Site	170/43	0200	170/80	0240	1.9
London WC	180/40	0200	180/82	0248	2.1
	180/42	0300	180/74	0325	1.8
	220/38	0500	220/71	0505	1.9
Post Office Tower	170/54	0200	170/94	0248	1.7
Gatwick	210/34	0400	210/86	0430	2.5
Ashford*	190/38E	0400	/92	0440	2.4
Sheerness	200/63	0400	200/93	0430	1.5
Langdon Bay	180/54	0300	180/94E	0342	1.7
	190/56	0400	190/94	0448	1.7
	200/53	0500	210/94	0530	1.8
Manston	210/58	0400	210/86	0436	1.5
Shoeburyness	230/56	0400	210/87	0443	1.6
Culdrose	350/48	0000	350/72	0020	1.5
Portland Bill	260/52	0300	270/78	0348	1.5
RNAS Portland	270/55	0300	260/86	0318	1.6
Southampton	170/30	0200	170/75	0215	2.5
Thorney Island*	200/59	0300	210/90	0342	1.5
Shoreham by Sea*	220/74	0300	220/98	0310	1.3
			220/98	0330	1.3
			/100E		
Herstmonceux	200/60E	0400	200/90	0455	(1.5)
Jersey Airport	220/55	0100	200/85	0102	1.5
Guernsey Airport	250/55	0200	250/81	0218	1.5
Coltishall	190/44	0400	180/71	0400	1.6
Hemsby	190/48	0500	190/79	0420	1.6
Gorleston	/66	0400	/106	0424	1.6
	/68	0500	/104	0516	1.5
Norwich WC	210/34	0600	/74	0416	
Wattisham	180/35	0300	180/72	0342	2.1
	200/44	0500	220/70	0502	1.6
	220/46	0600	220/70	0622	1.5

E Denotes an estimated value
* Indicates an interrupted record

Table 1.3 *A comparison of the gust ratios (mean, standard deviation (s.d.) and number (n)) of 16 October 1987 with those of three previous storms*

		All gusts for mean speed ≧ 25 kn	Gusts ≧ 60 kn	Extreme gusts at each station
16 October 1987	mean	1.68	1.70	1.76
	s.d.	0.23	0.37	0.36
	n	111	46	39
27 March 1987	mean	—	—	1.77
	s.d.	—	—	0.23
	n	—	—	49
24 March 1986	mean	1.70	1.68	1.71
	s.d.	0.16	0.12	0.15
	n	148	25	23
2 January 1976	mean	—	—	1.73
	s.d.	—	—	0.27
	n	—	—	30

Table 1.4 *Estimated return periods (in years)*

Station	First year of period analysed	Highest mean wind	Return period	Highest gust	Return period
Boscombe Down	1933	39	7	70	22
Brize Norton	1969	26	1	50	1
Coltishall	1968	44	12	71	6
Farnborough	1971	35*	120	61†	16
Gatwick	1960	34‡	4	86*	>200
Gorleston	1913§	68*	>200	106*	>200
Heathrow (SW site)	1959	39*	20	66*	35
Hurn	1960	36	6	61	8
Jersey	1958	55	10	85	15
London WC	1965	42*	100	82*	120
Manston	1967	58*	>200	86*	>200
Portland Bill	1970	52	7	78†	18
Shoeburyness	1926	56*	>200	87*	>200
Stansted	1962	35	12	65	20
Thorney Island	1943§	59*	>200	90*	>200
Wattisham	1970	46	20	72	10

* Speed has not been reached before during period of record

† Speed has been reached, but not exceeded, during period of record

‡ Unrepresentative, because of exposure of anemometer

§ There are gaps in the records for this station.

Table 1.5 *Highest wind speeds (kn) recorded in October*

Station	Year of first record	Hourly mean speed 16 Oct.	Hourly mean speed Previous highest and year	Gust speed 16 Oct.	Gust speed Previous highest and year
Boscombe Down	1932	39	38 1967	70	70 1945
Gatwick	1960	34	32 1967	86	56 1971
Gorleston	1913*	68	41 1926 1955	106	68 1976
Heathrow	1959	39	34 1959	66	52 1959
Jersey	1958	55	68 1964	85	94 1964
London WC	1965	42	30 1971 1983	82	57 1981
Manston	1967	58	42 1967	86	64 1967
Shoeburyness	1913	56	49 1967	87	74 1949

* There are gaps in the records for this station

Table 1.6 *Exceptional gales which have caused extensive damage within living memory*

Period	Area	Reason
6 January 1928	All UK	Gale with North Sea floods
14/15 January 1952	All UK	Severe gale; hurricane force winds over north of Scotland
30 January/ 1 February 1953	All UK	Severe NW gale; North Sea floods
4 November 1957	All UK	Exceptional gale
27 January 1961	Scotland	Hurricane force winds over the north of Scotland
11–18 February 1962	All UK	Exceptional gales; Sheffield storm damage
14/15 January 1968	Scotland	Exceptional gales; much damage in the Glasgow area
2 January 1976	All UK	Gales with North Sea floods
11 November 1977	N England	Gale and unusually high tide
3 January 1984	Northern areas	Severe gales; hurricane force winds in Scotland
24 March 1986	Southern areas	Atlantic depression; Severn Bridge closed
25/26 August 1986	All UK	Former hurricane
27 March 1987	All UK	Gales

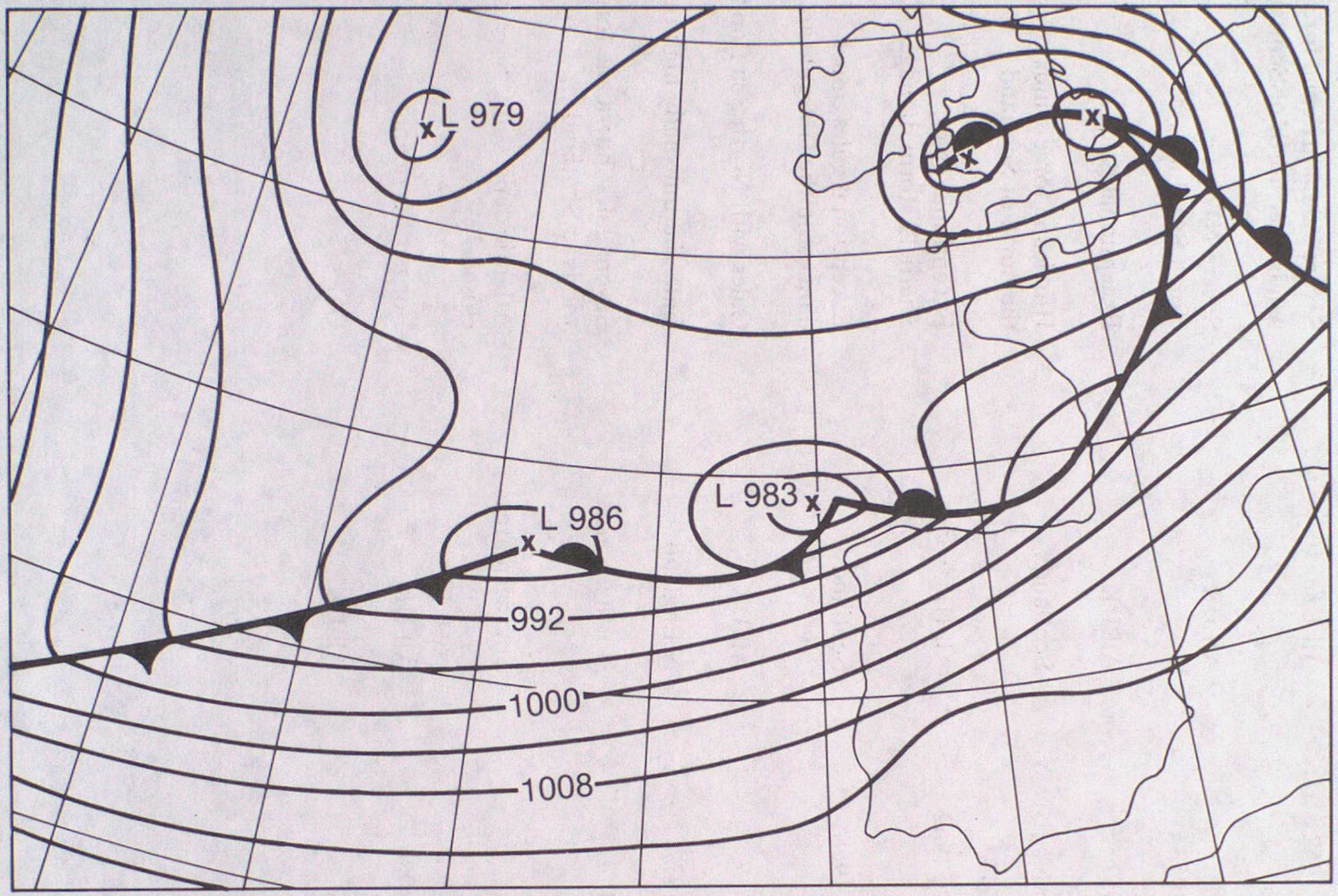

L 979
L 986
L 983
992
1000
1008

Figure 1.1(a) Finalized surface analysis 0000 GMT 15 October 1987.

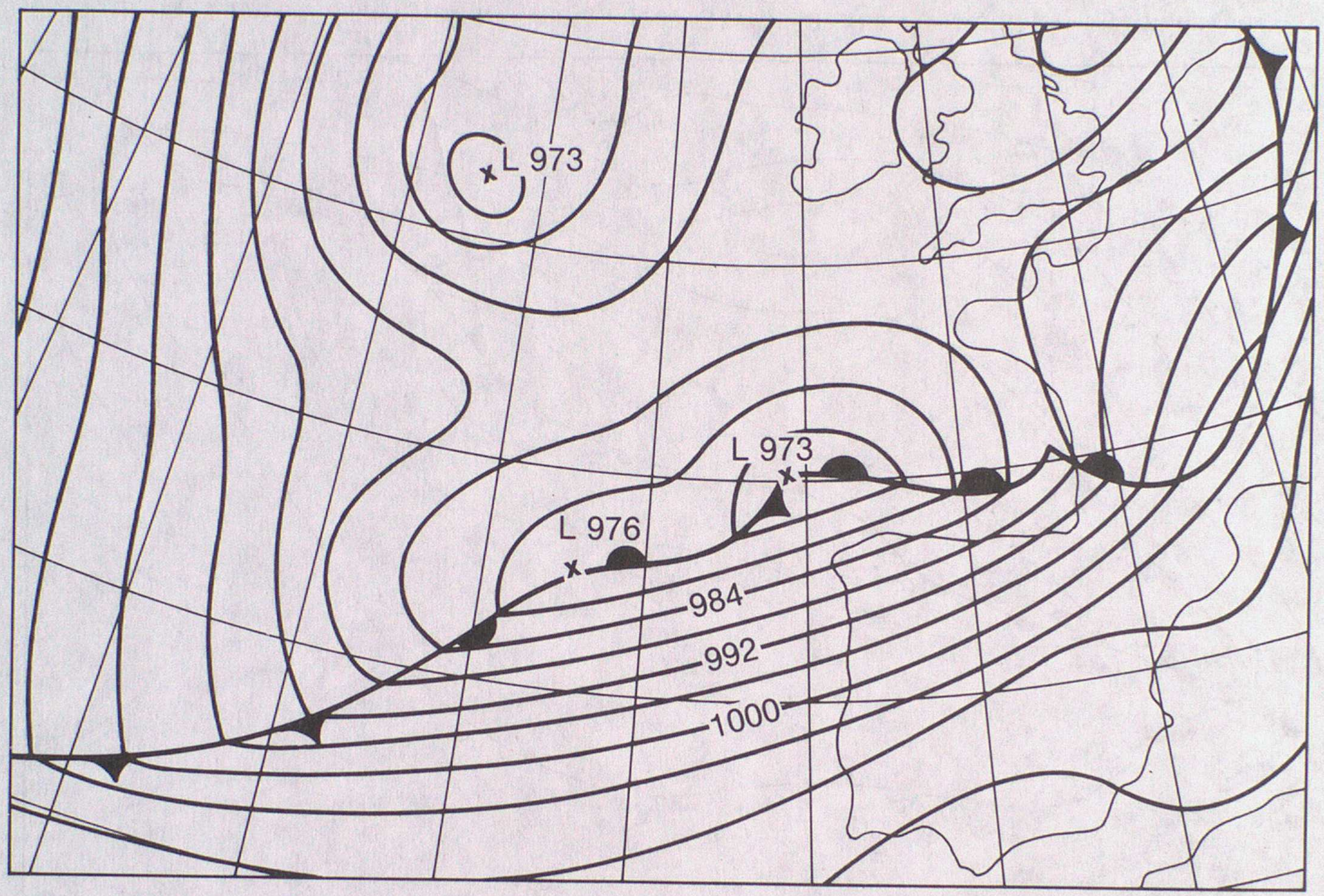

L 973
L 973
L 976
984
992
1000

Figure 1.1(b) Finalized surface analysis 0600 GMT 15 October 1987.

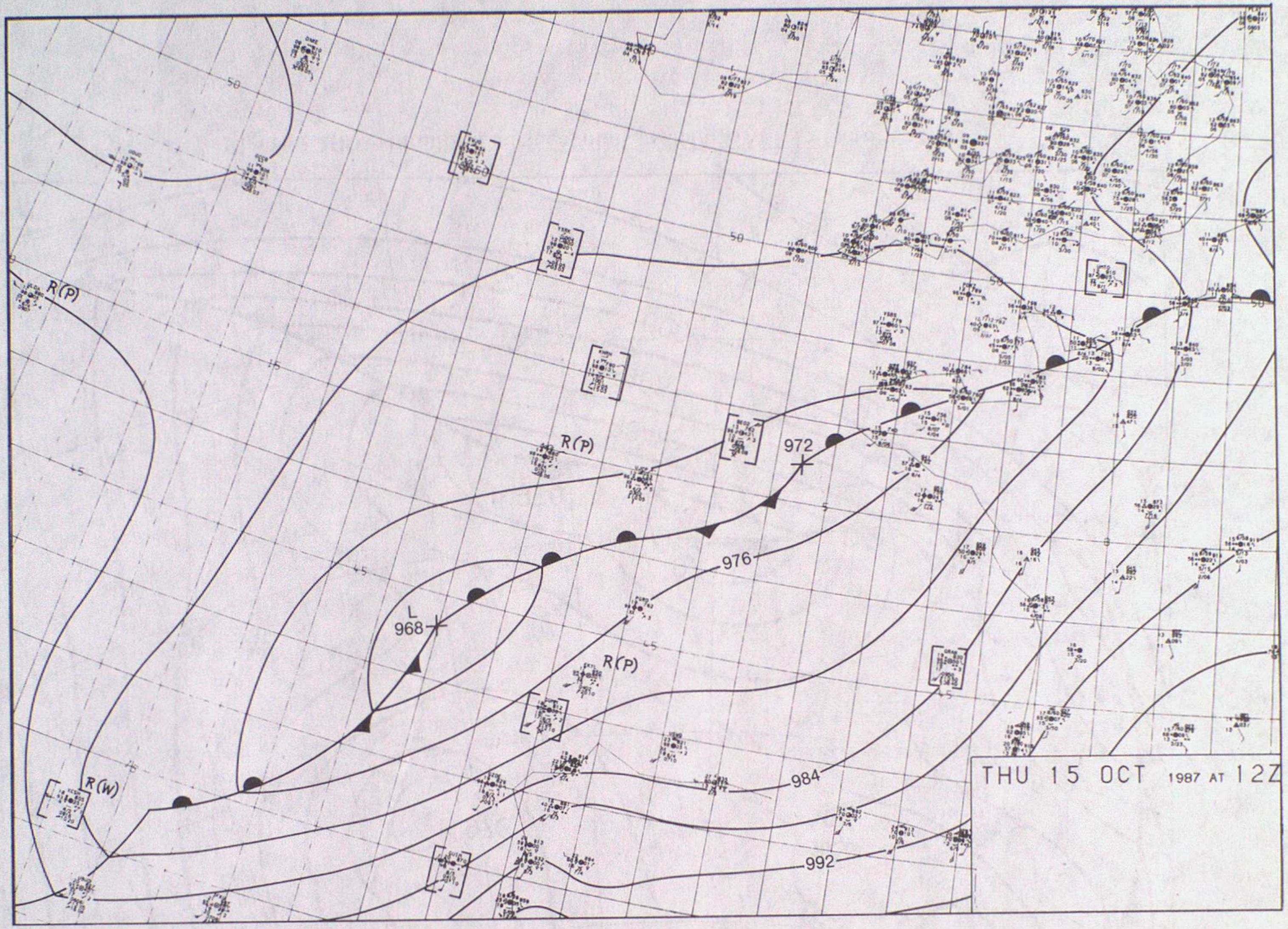

THU 15 OCT 1987 AT 12Z
L
968
972
976
984
992
R(P)
R(P)
R(P)
R(W)
50
50
50
45
45
45

Figure 1.1(c) Finalized surface analysis 1200 GMT 15 October 1987. Ship observations not available at the time of the operational analysis are enclosed within square brackets and ships for which pressure or wind observations were rejected by the CFO forecasters are annotated R(P) and R(W).

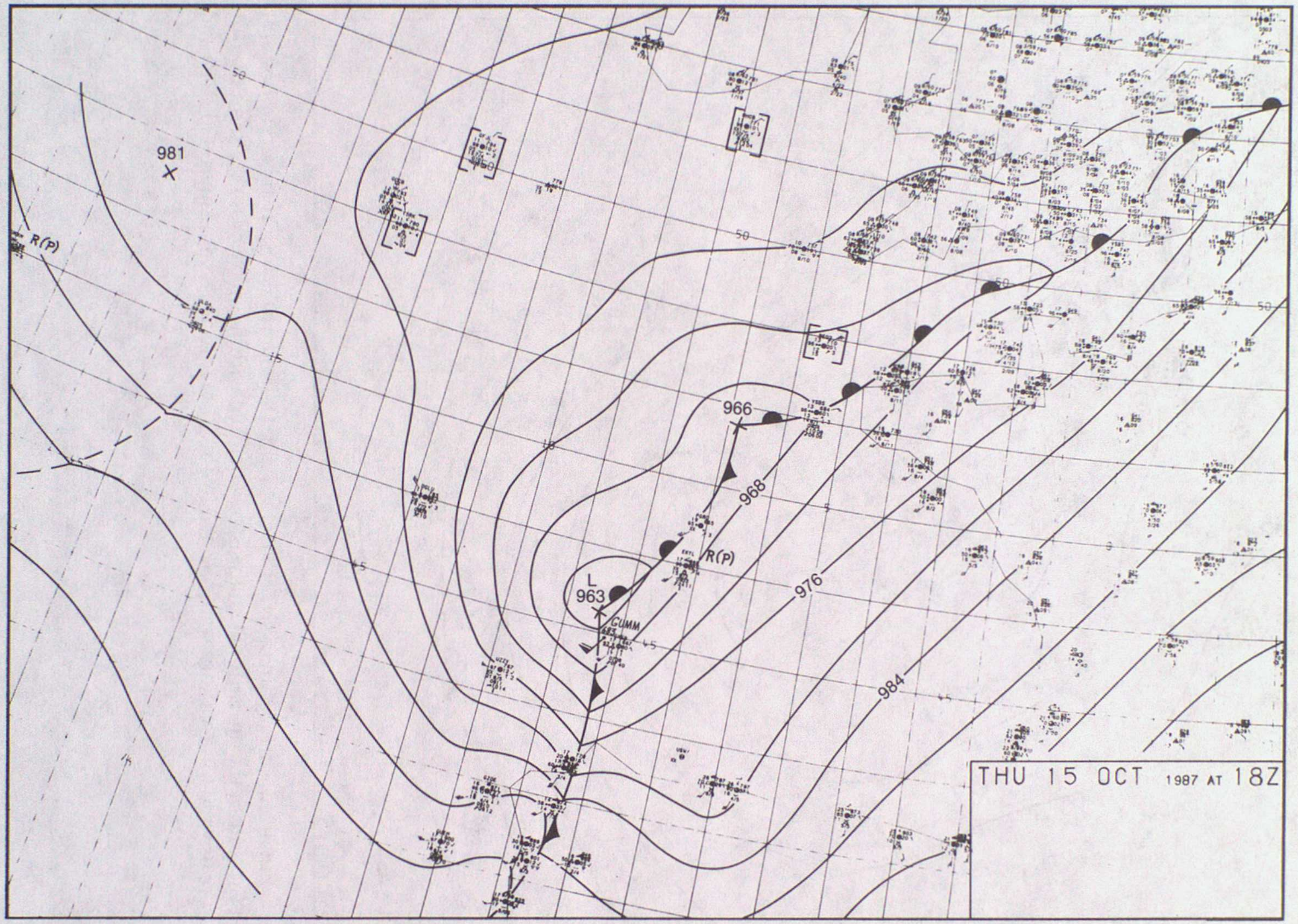

THU 15 OCT 1987 AT 18Z
981
R(P)
966
968
R(P)
L
963
CUMM
976
984
50
15
10
5
45

Figure 1.1(d) Finalized surface analysis 1800 GMT 15 October 1987. Ship observations not available at the time of the operational analysis are enclosed within square brackets and ships for which pressure or wind observations were rejected by the CFO forecasters are annotated R(P) and R(W).

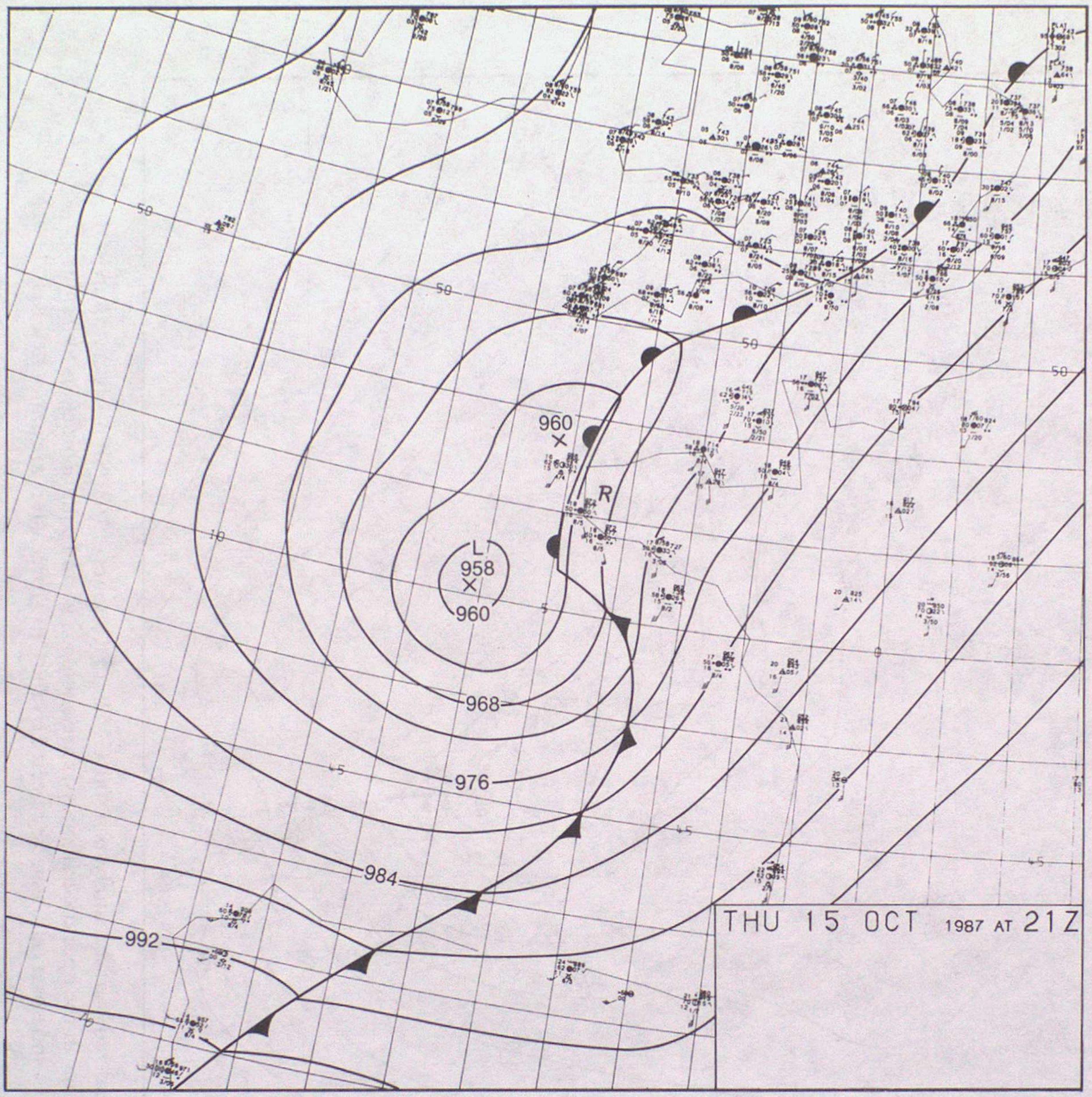

THU 15 OCT 1987 AT 21Z
L
958
960
960
968
976
984
992
R
50
50
50
50
10
5
45
45
45

Figure 1.1(e) Finalized surface analysis 2100 GMT 15 October 1987. Ship observations not available at the time of the operational analysis are enclosed within square brackets and ships for which pressure or wind observations were rejected by the CFO forecasters are annotated R(P) and R(W).

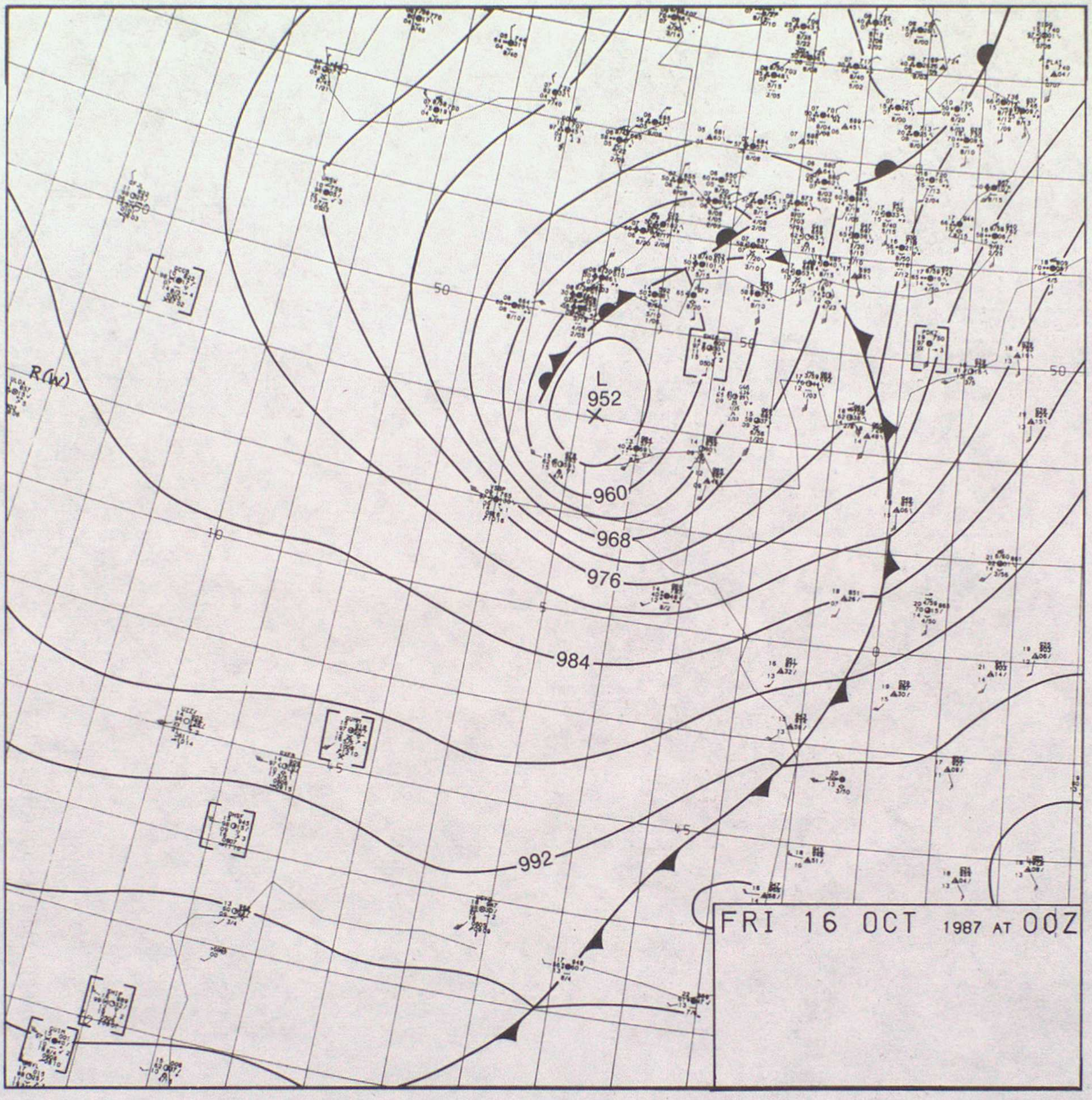

R(W)
50
L
952
960
968
976
984
992
10
5
0
45
50
FRI 16 OCT 1987 AT 00Z

Figure 1.1(f) Finalized surface analysis 0000 GMT 16 October 1987. Ship observations not available at the time of the operational analysis are enclosed within square brackets and ships for which pressure or wind observations were rejected by the CFO forecasters are annotated R(P) and R(W).

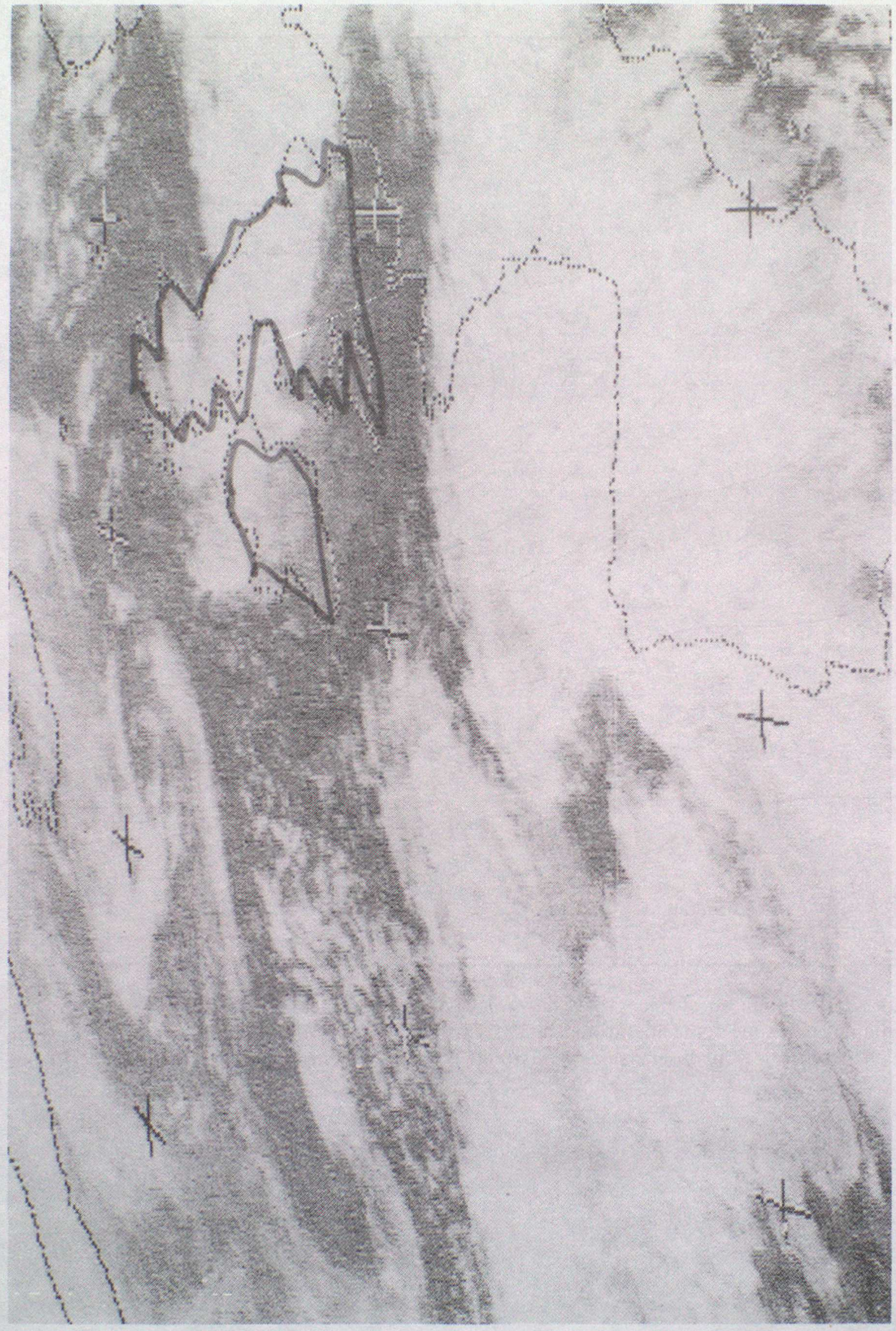


Figure 1.2(a) Meteosat infra-red imagery 0000 GMT 15 October 1987.

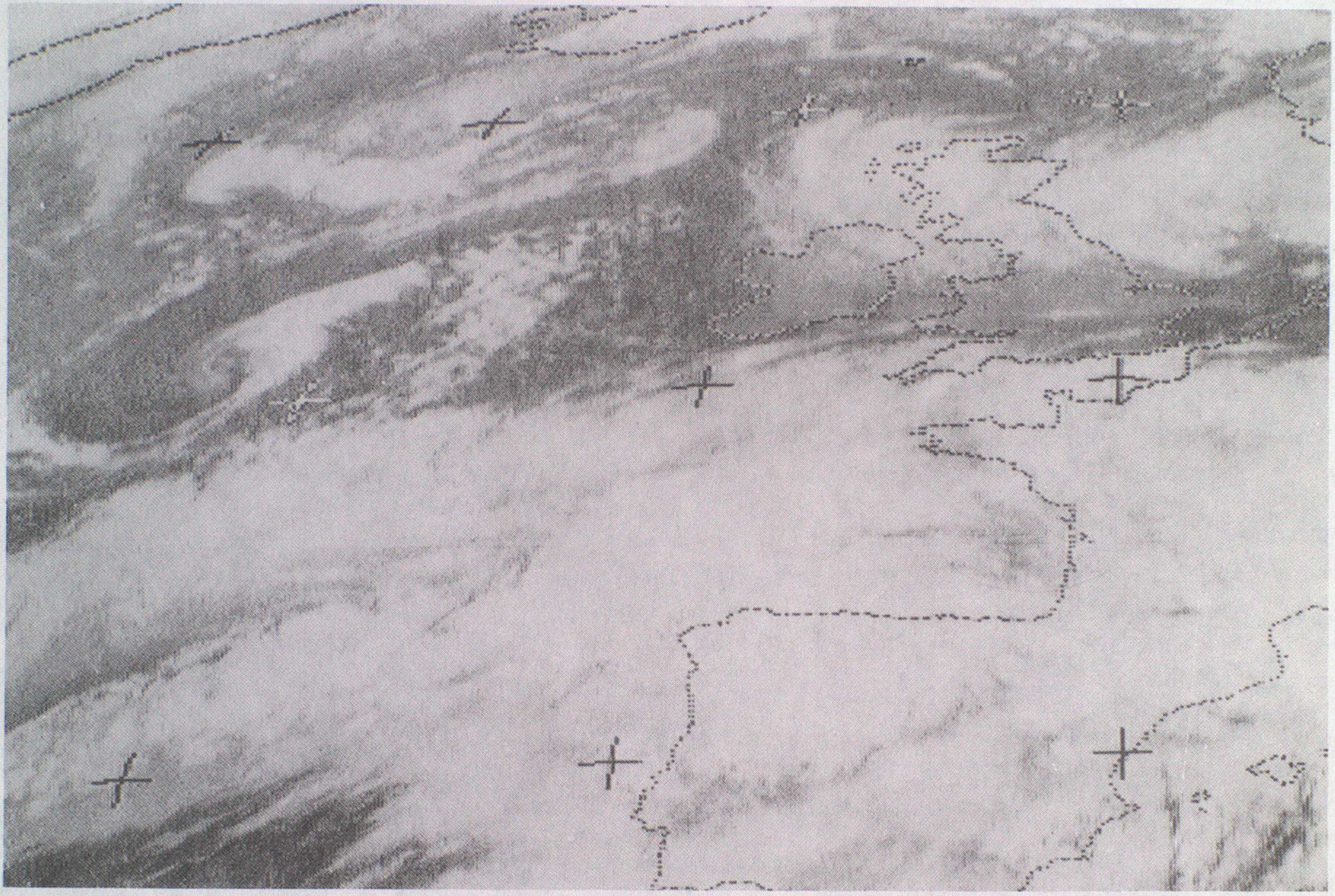


Figure 1.2(b) Meteosat infra-red imagery 0600 GMT 15 October 1987.

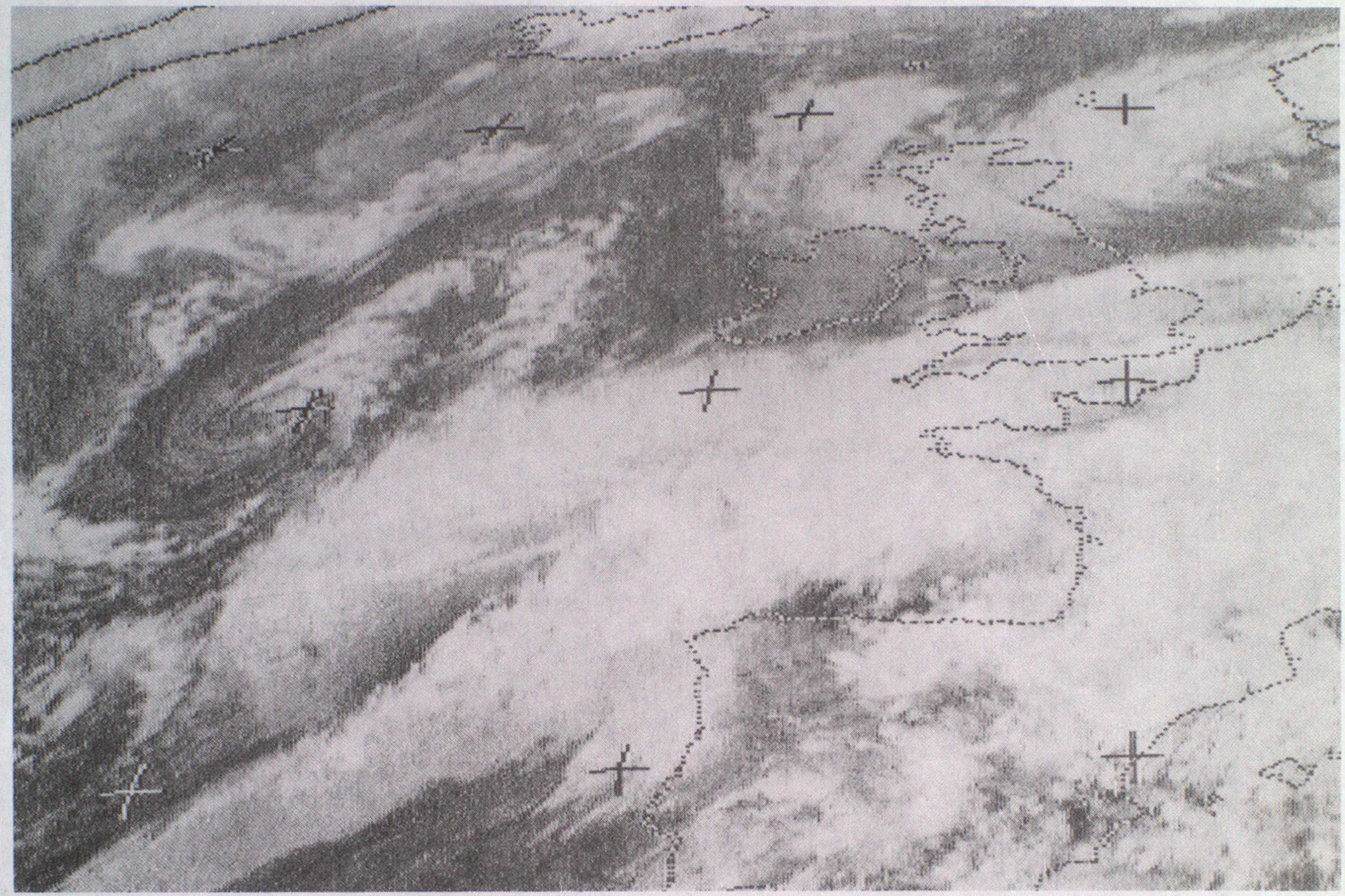


Figure 1.2(c) Meteosat infra-red imagery 1200 GMT 15 October 1987.

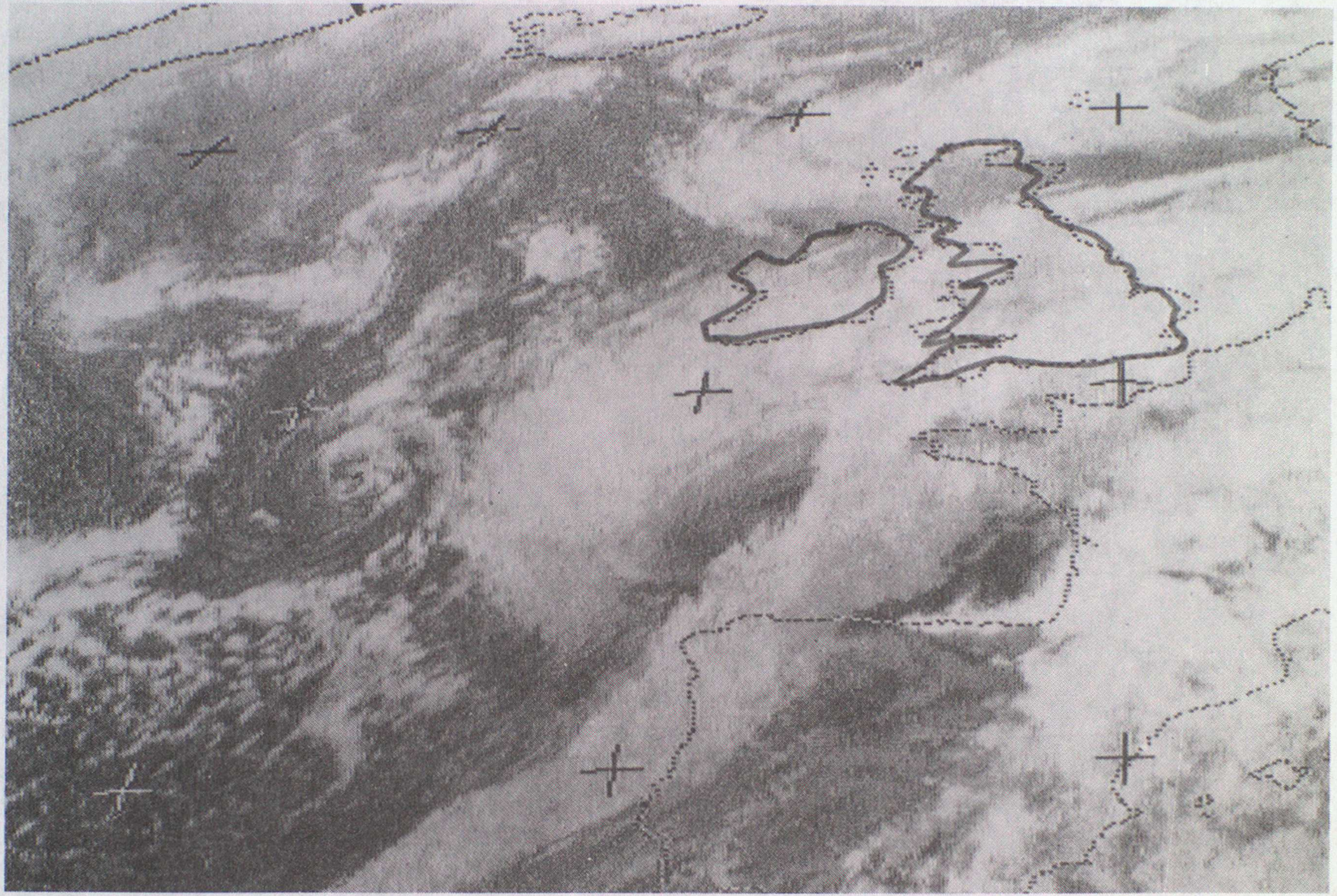


Figure 1.2(d) Meteosat infra-red imagery 1800 GMT 15 October 1987.

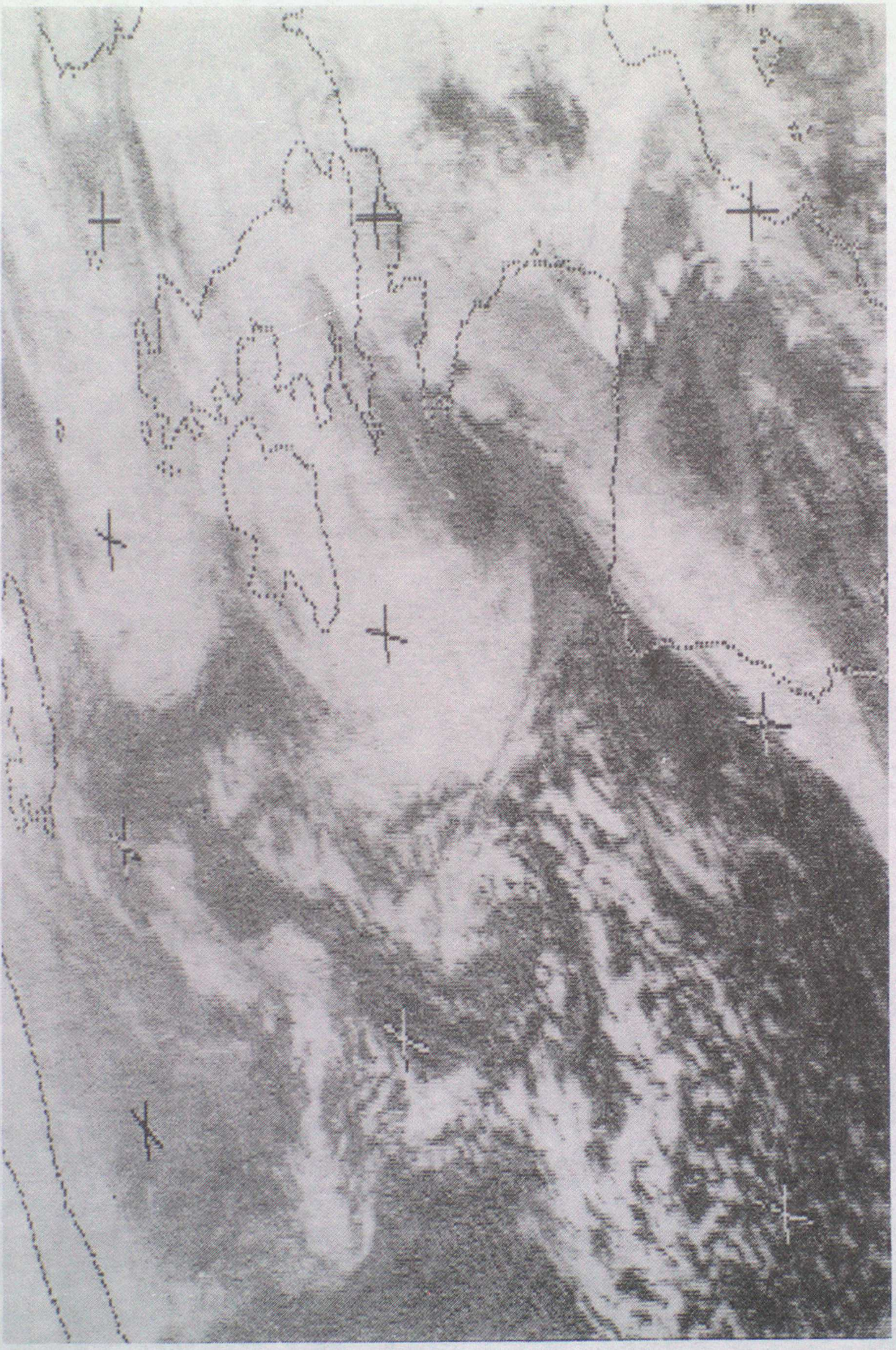


Figure 1.2(e) Meteosat infra-red imagery 2100 GMT 15 October 1987.

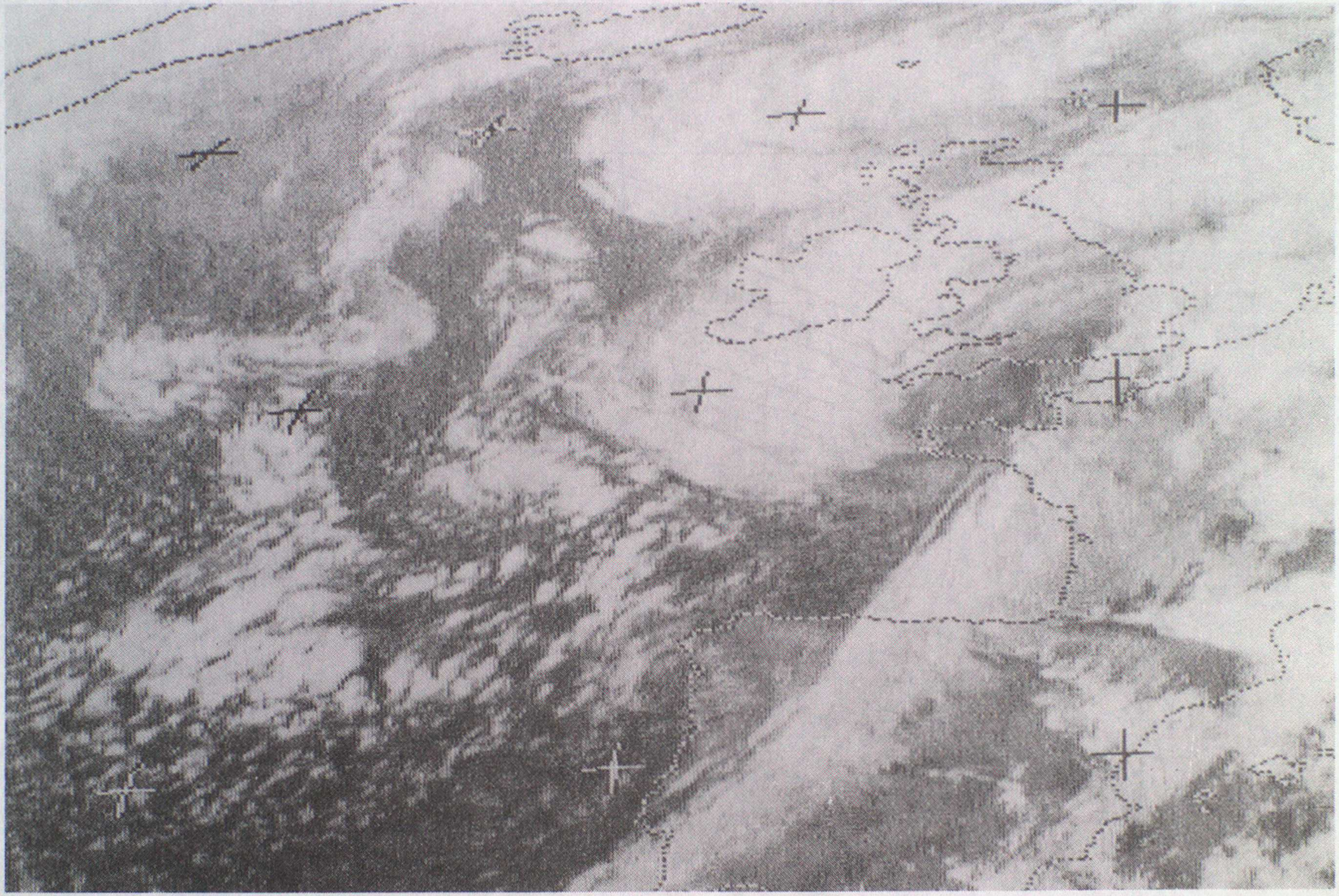


Figure 1.2(f) Meteosat infra-red imagery 0000 GMT 16 October 1987.

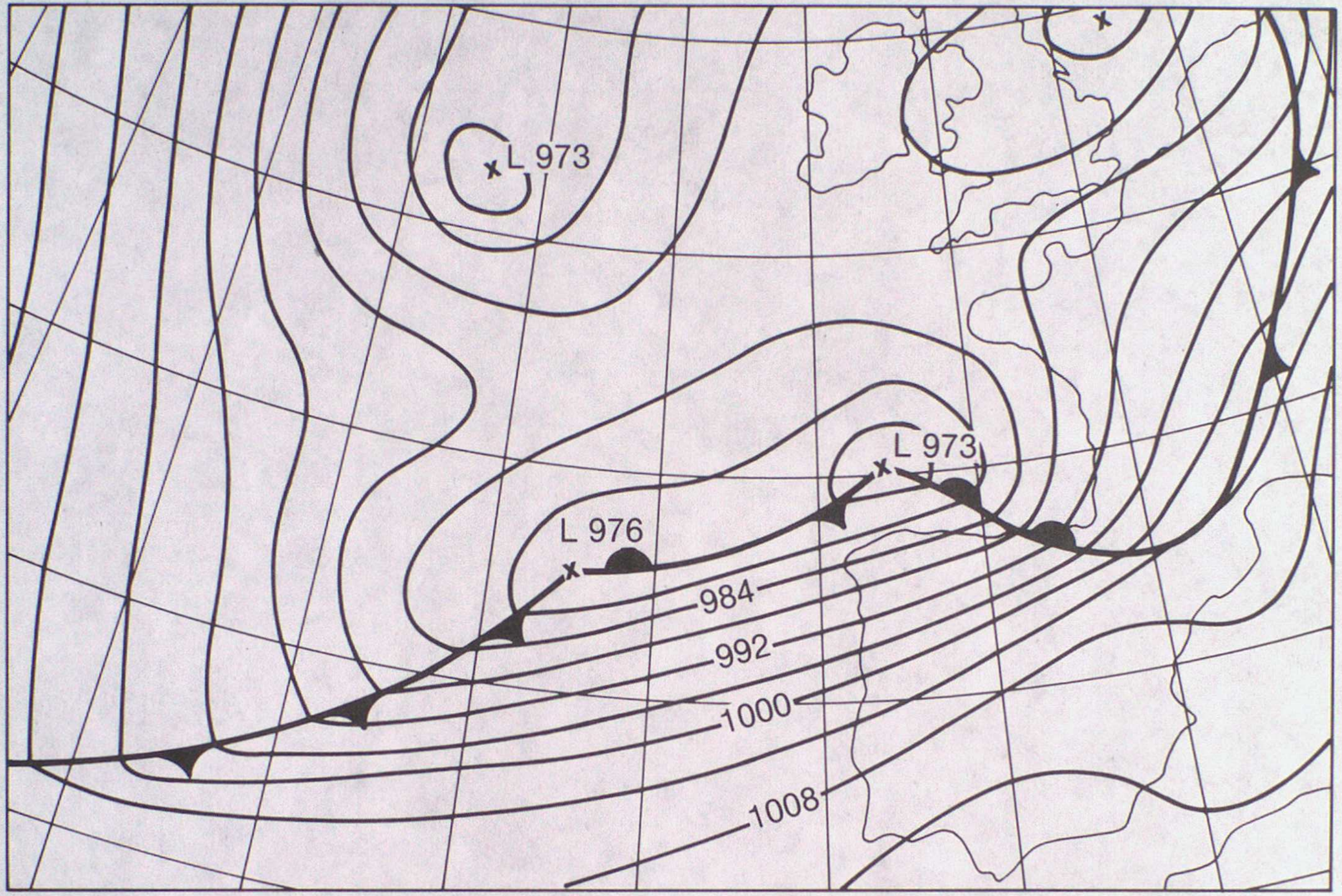

L 973
L 973
L 976
984
992
1000
1008

Figure 1.3(a) CFO operational surface analysis 0600 GMT 15 October 1987.

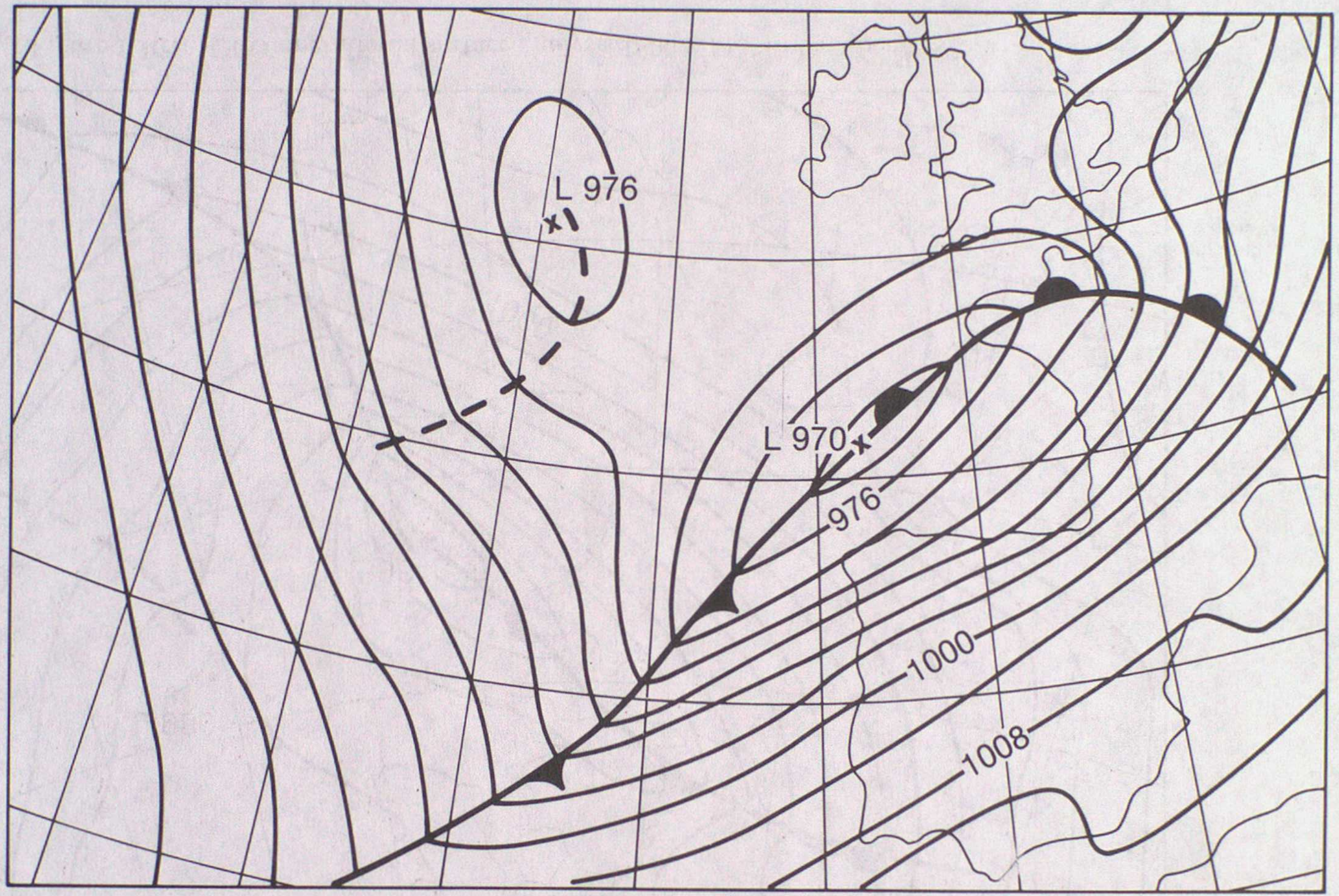

L 976
L 970
976
1000
1008

Figure 1.3(b) CFO operational surface analysis 1200 GMT 15 October 1987.

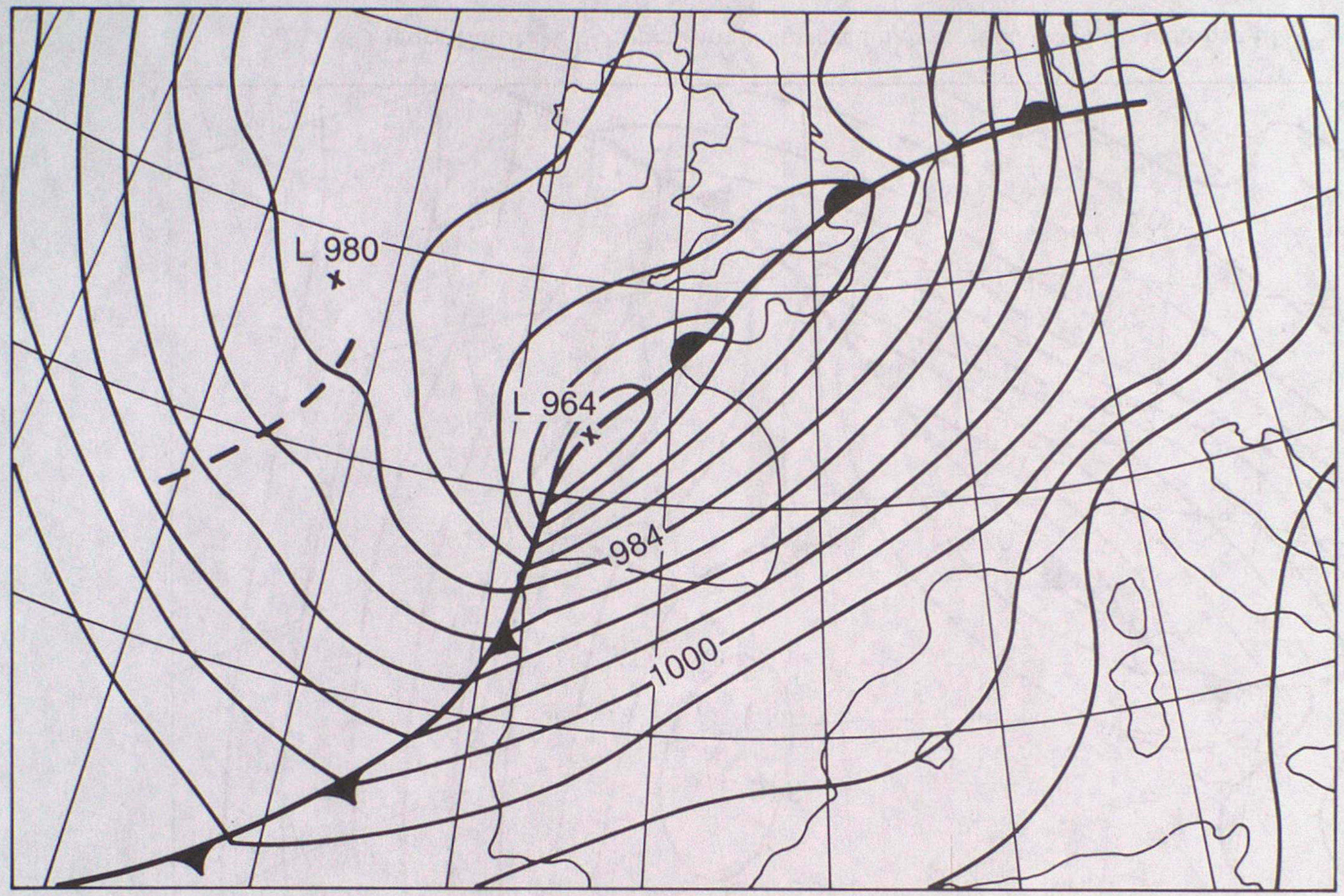

L 980
L 964
984
1000

Figure 1.3(c) CFO operational surface analysis 1800 GMT 15 October 1987.

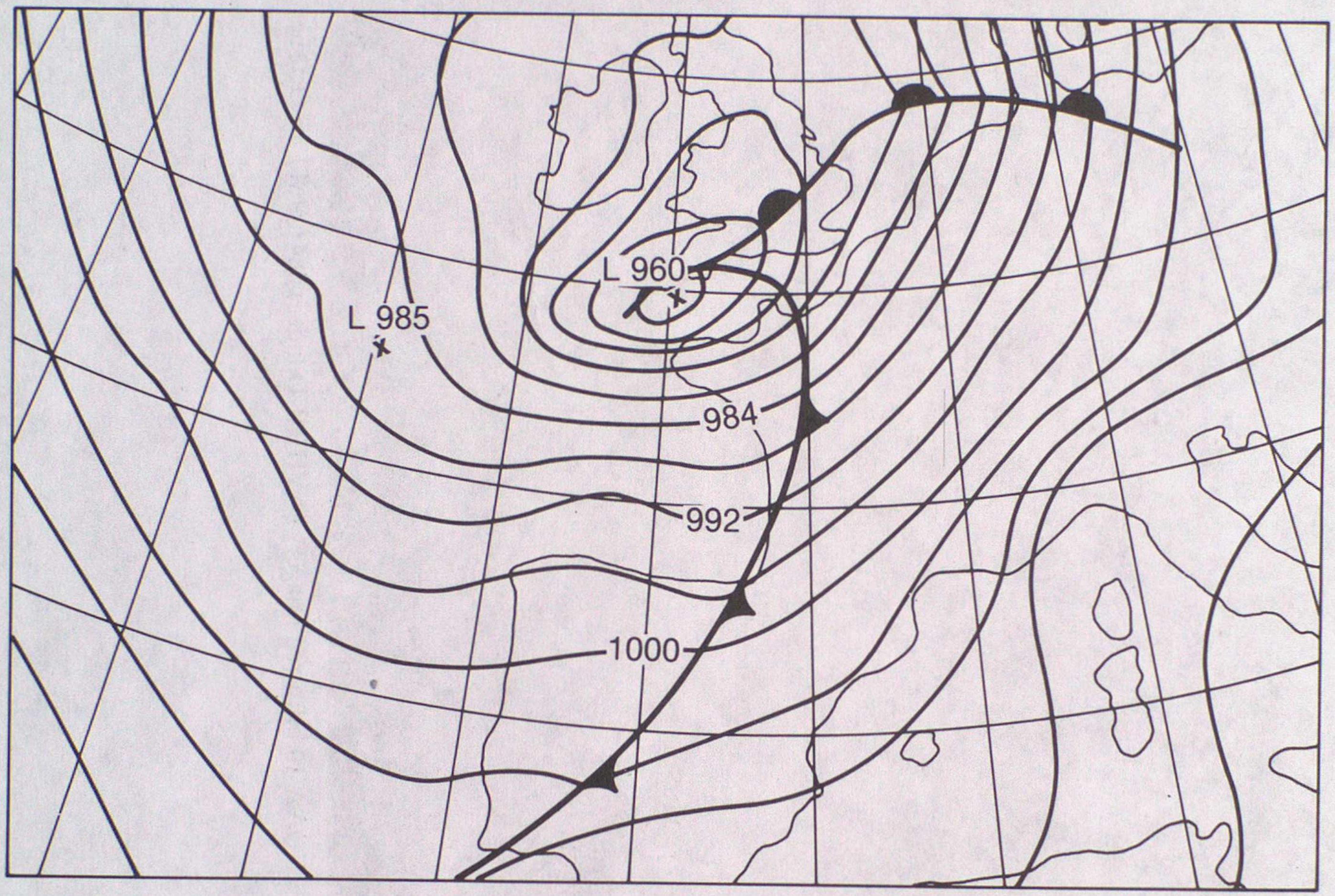

L 960
L 985
984
992
1000

Figure 1.3(d) CFO operational surface analysis 0000 GMT 16 October 1987.

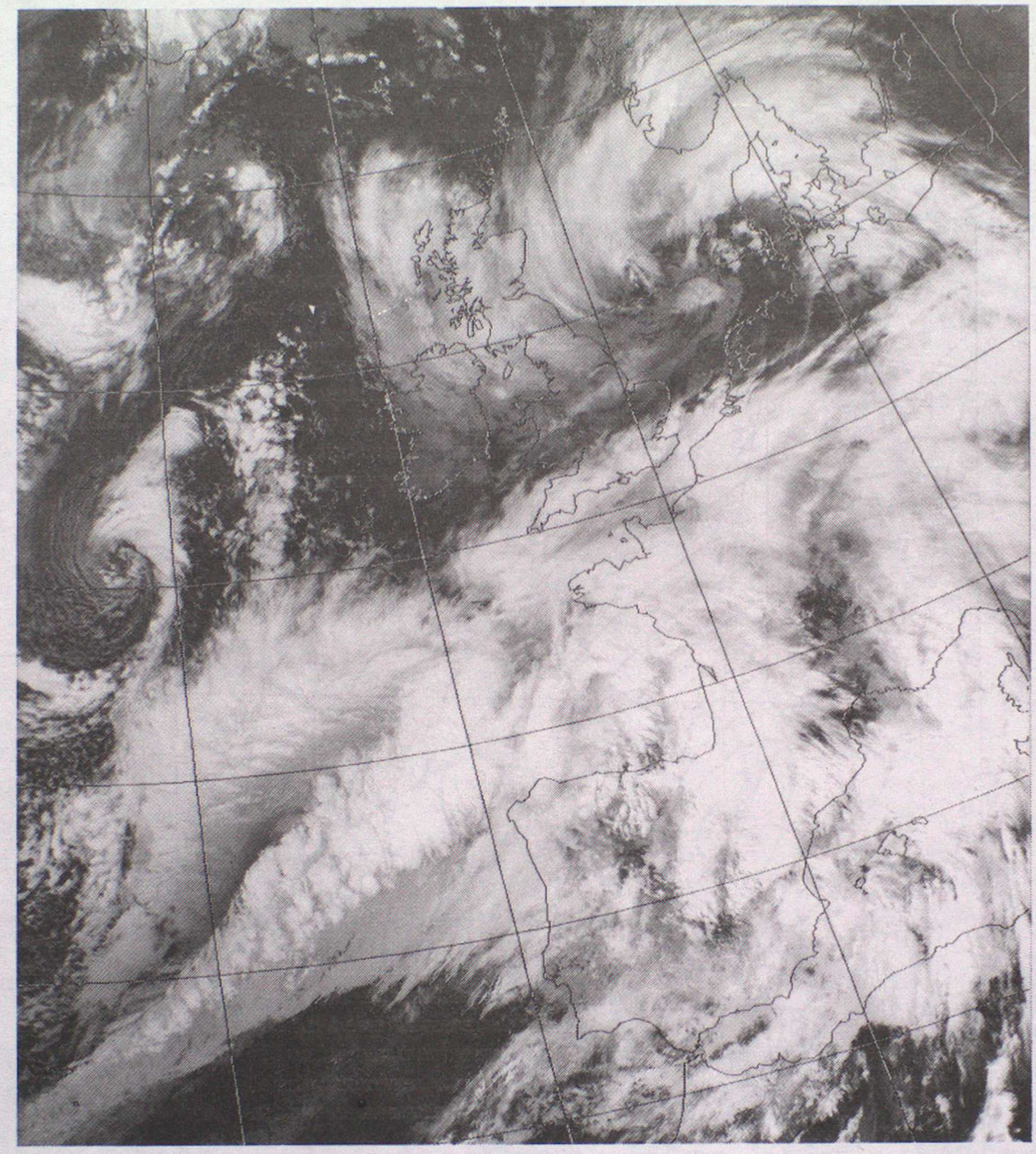


Figure 1.4(a) NOAA-10 infra-red imagery (AVHRR Dundee) 0841 GMT 15 October 1987.

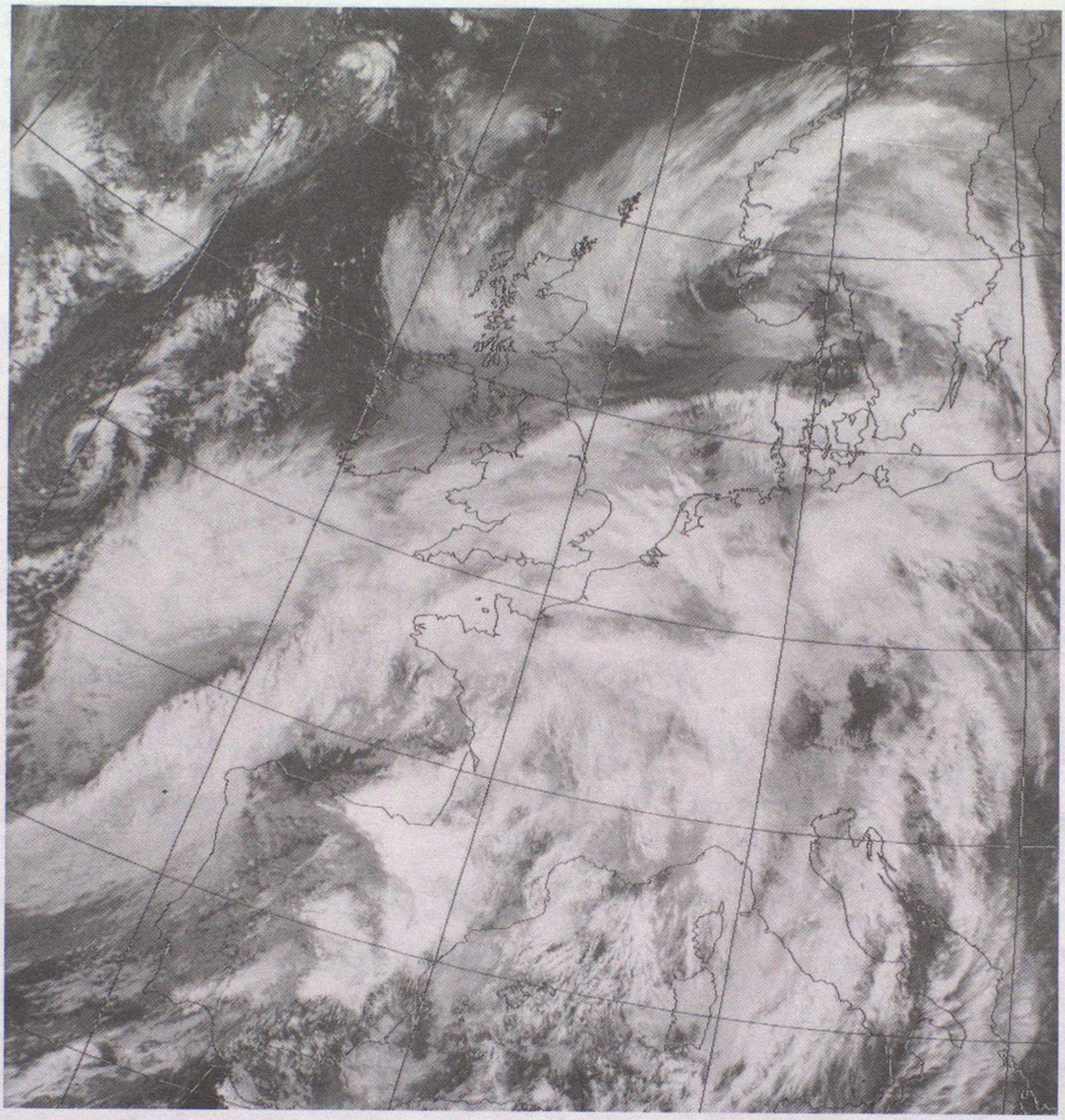


Figure 1.4(b) NOAA-9 infra-red imagery (AVHRR Dundee) 1447 GMT 15 October 1987.

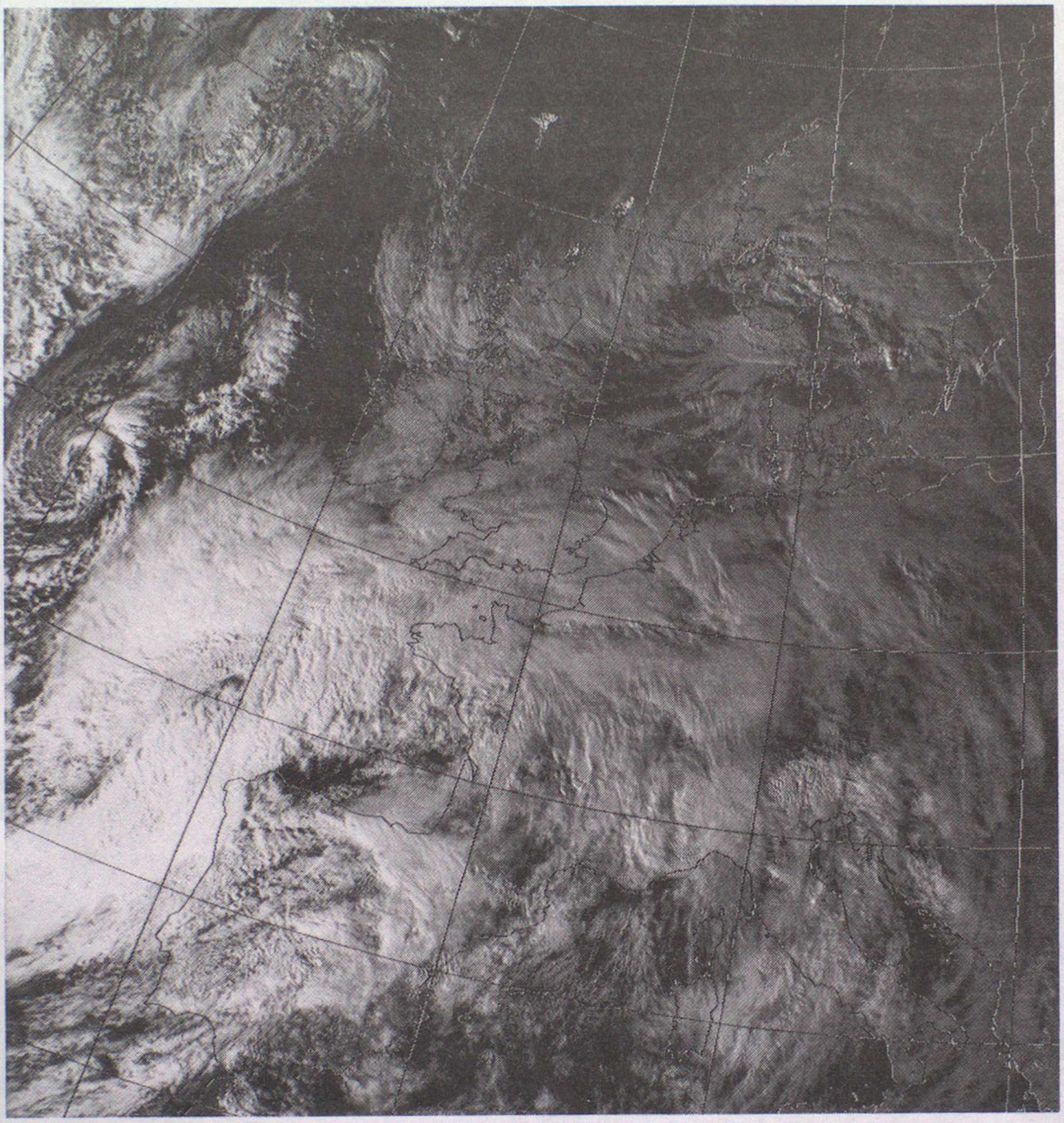


Figure 1.4(c) NOAA-9 visible imagery (AVHRR Dundee) 1447 GMT 15 October 1987.

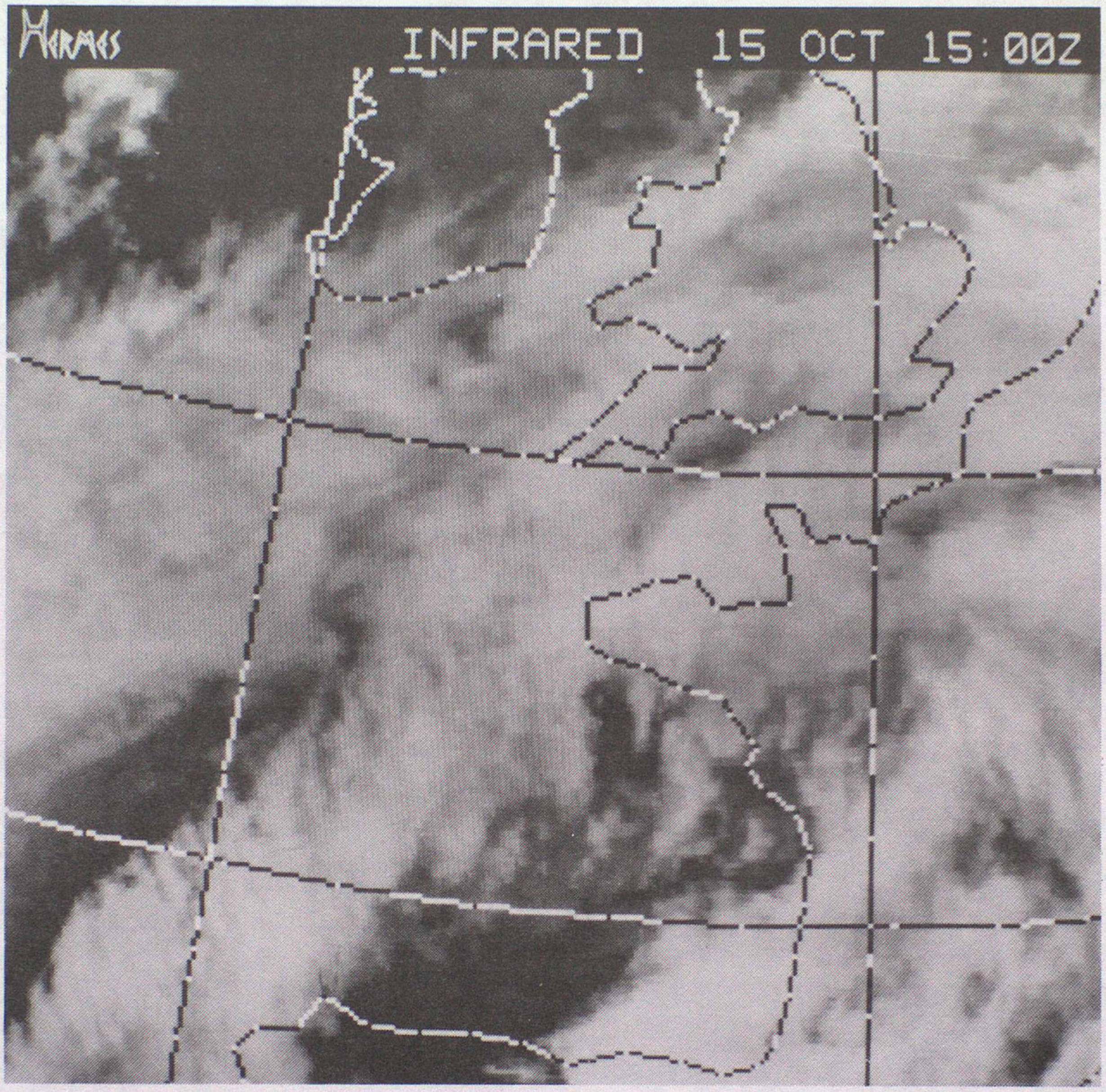

HERMES
INFRARED 15 OCT 15:00Z

Figure 1.5(a) Infra-red image from the HERMES system for 1500 GMT on 15 October 1987.

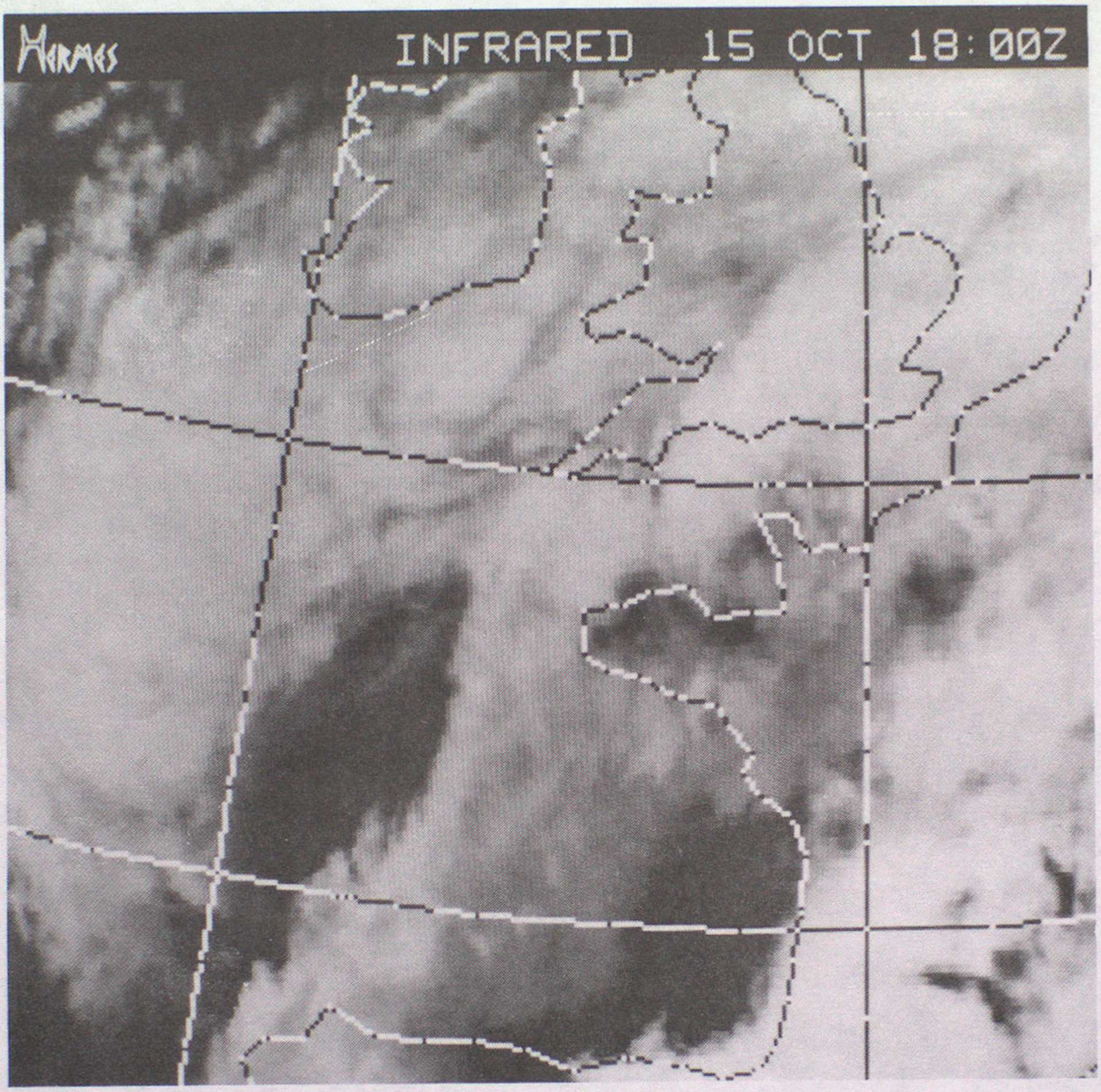

HERMES
INFRARED 15 OCT 18:00Z

Figure 1.5(b) Infra-red image from the HERMES system for 1800 GMT on 15 October 1987.

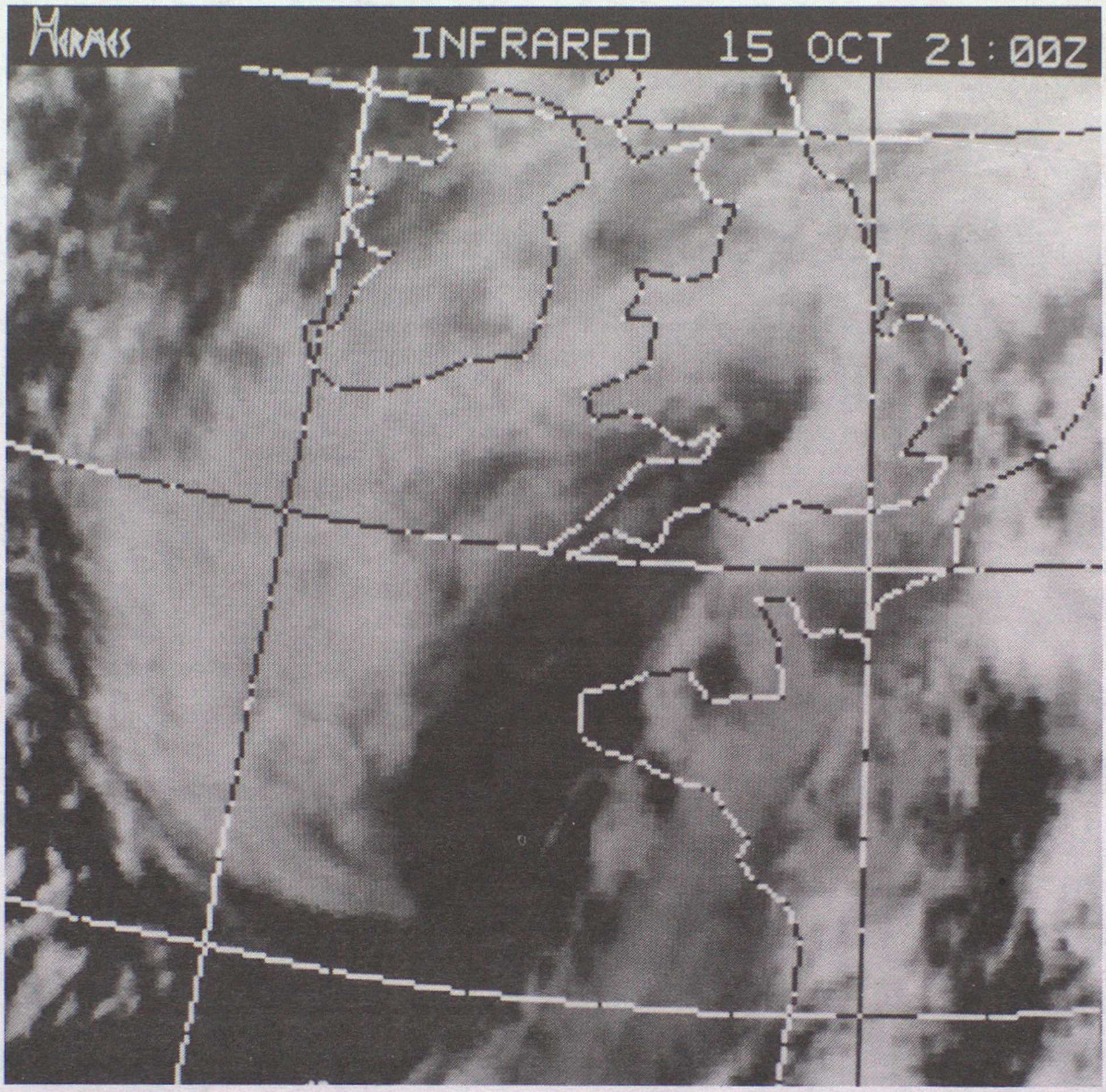

HERMES
INFRARED 15 OCT 21:00Z

Figure 1.5(c) Infra-red image from the HERMES system for 2100 GMT on 15 October 1987.

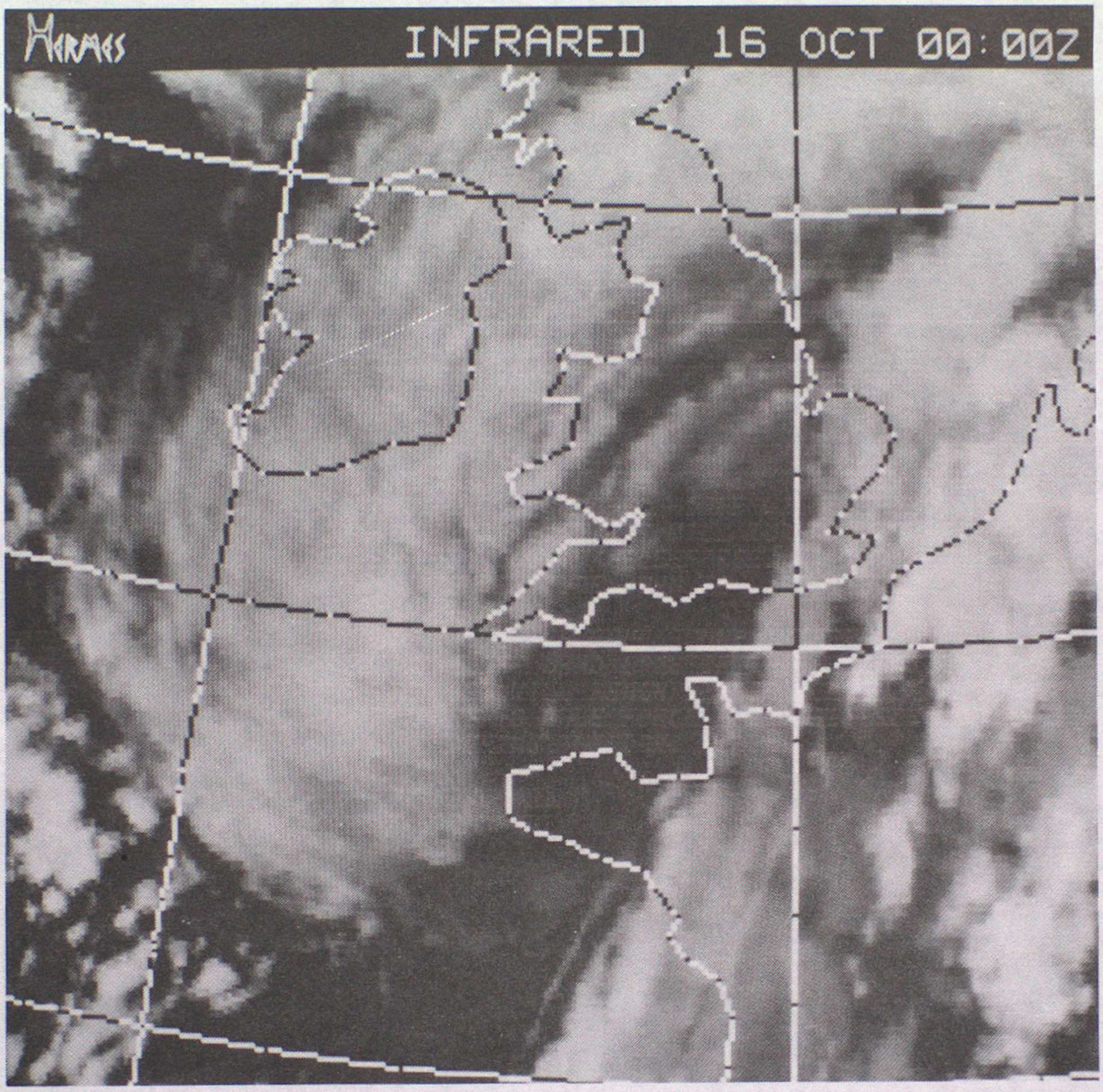

HERMES
INFRARED 16 OCT 00:00Z

Figure 1.5(d) Infra-red image from the HERMES system for 0000 GMT on 16 October 1987.

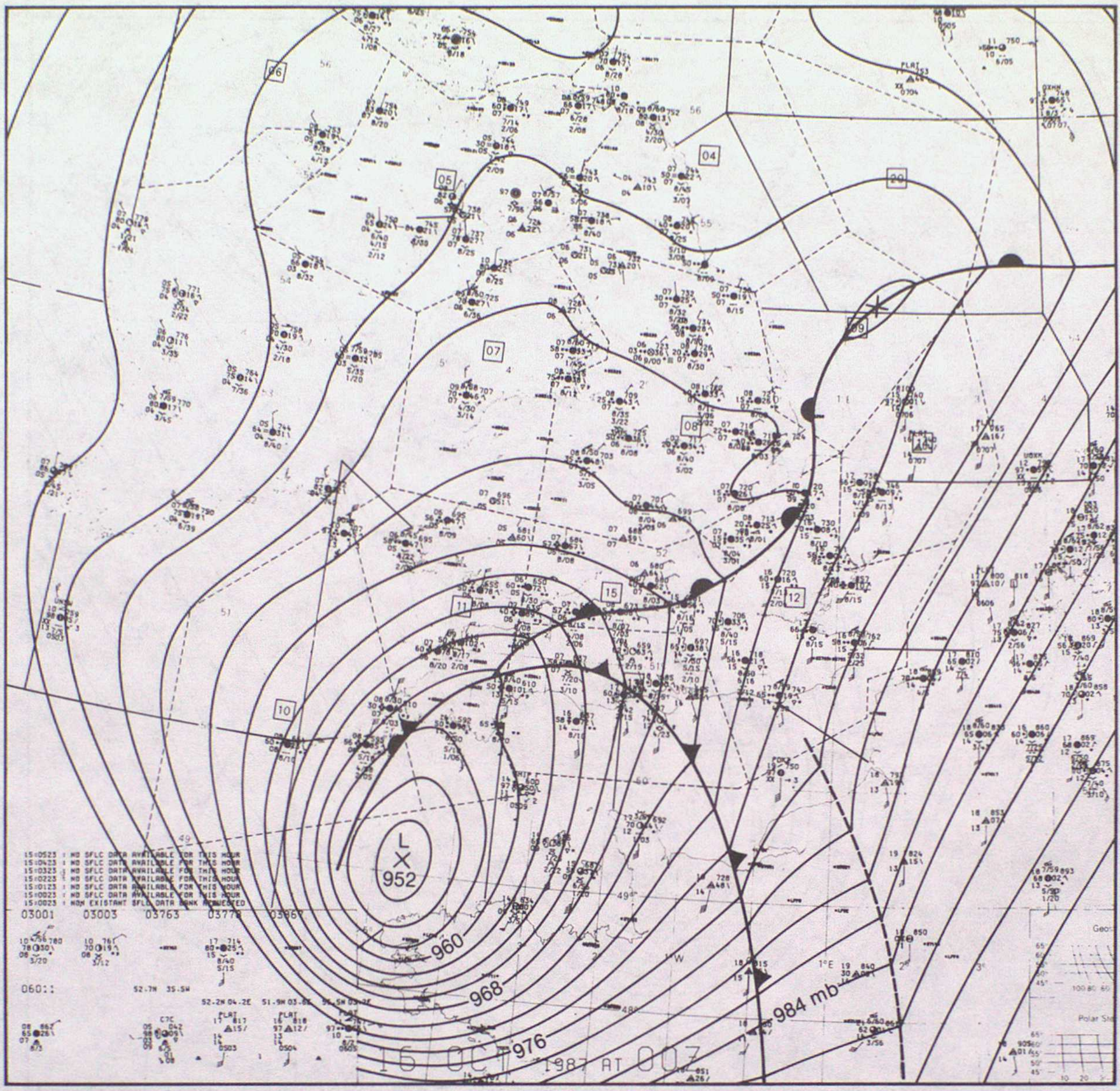

L
952
960
968
976
984 mb
16 OCT 1987 AT 00Z

Figure 1.6(a) UK surface analysis 0000 GMT 16 October 1987.

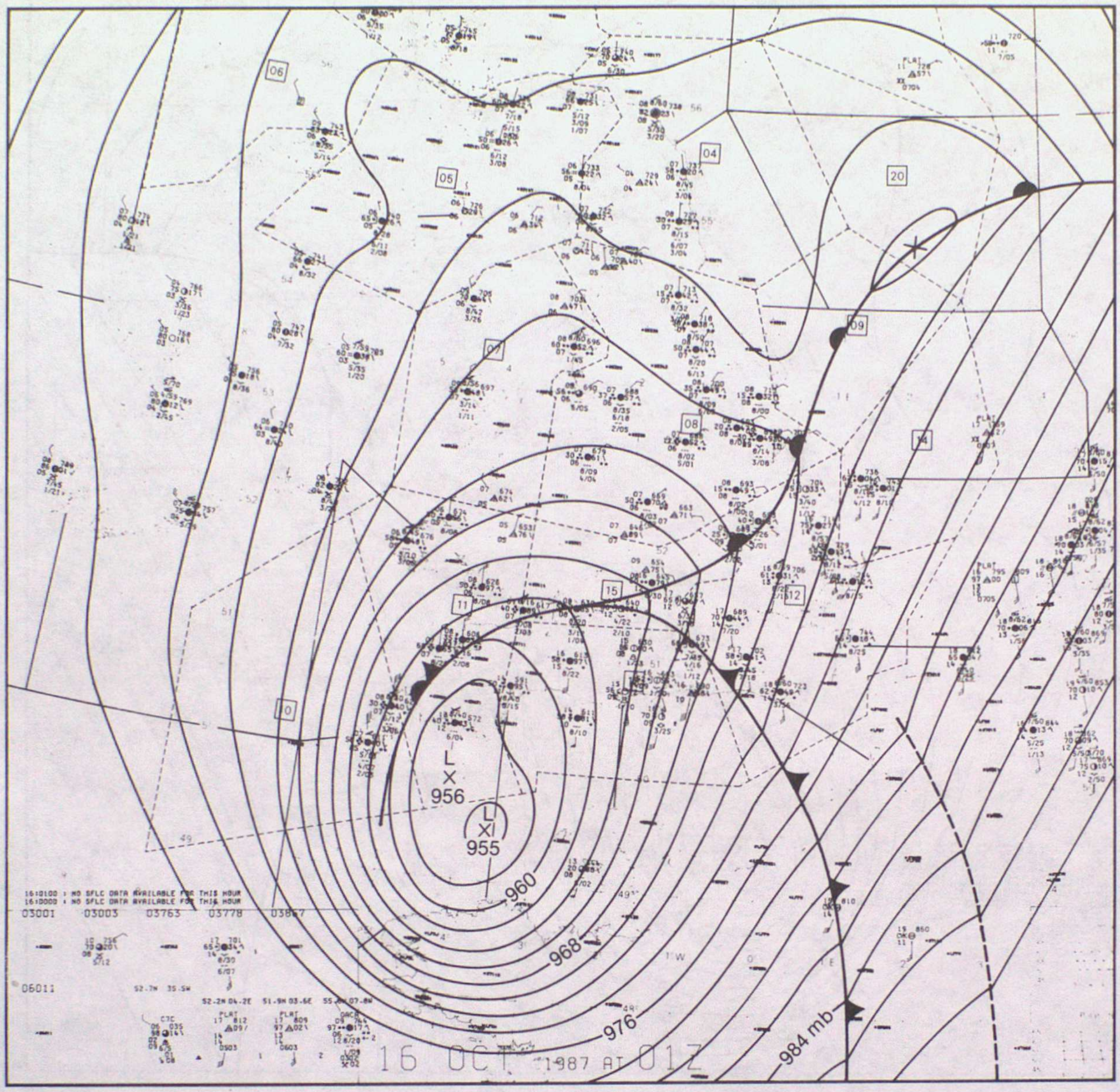

06
05
04
20
09
07
08
14
15
11
12
10
L
956
L
955
960
968
976
984 mb
16 OCT 1987 AT 01Z

Figure 1.6(b) UK surface analysis 0100 GMT 16 October 1987.

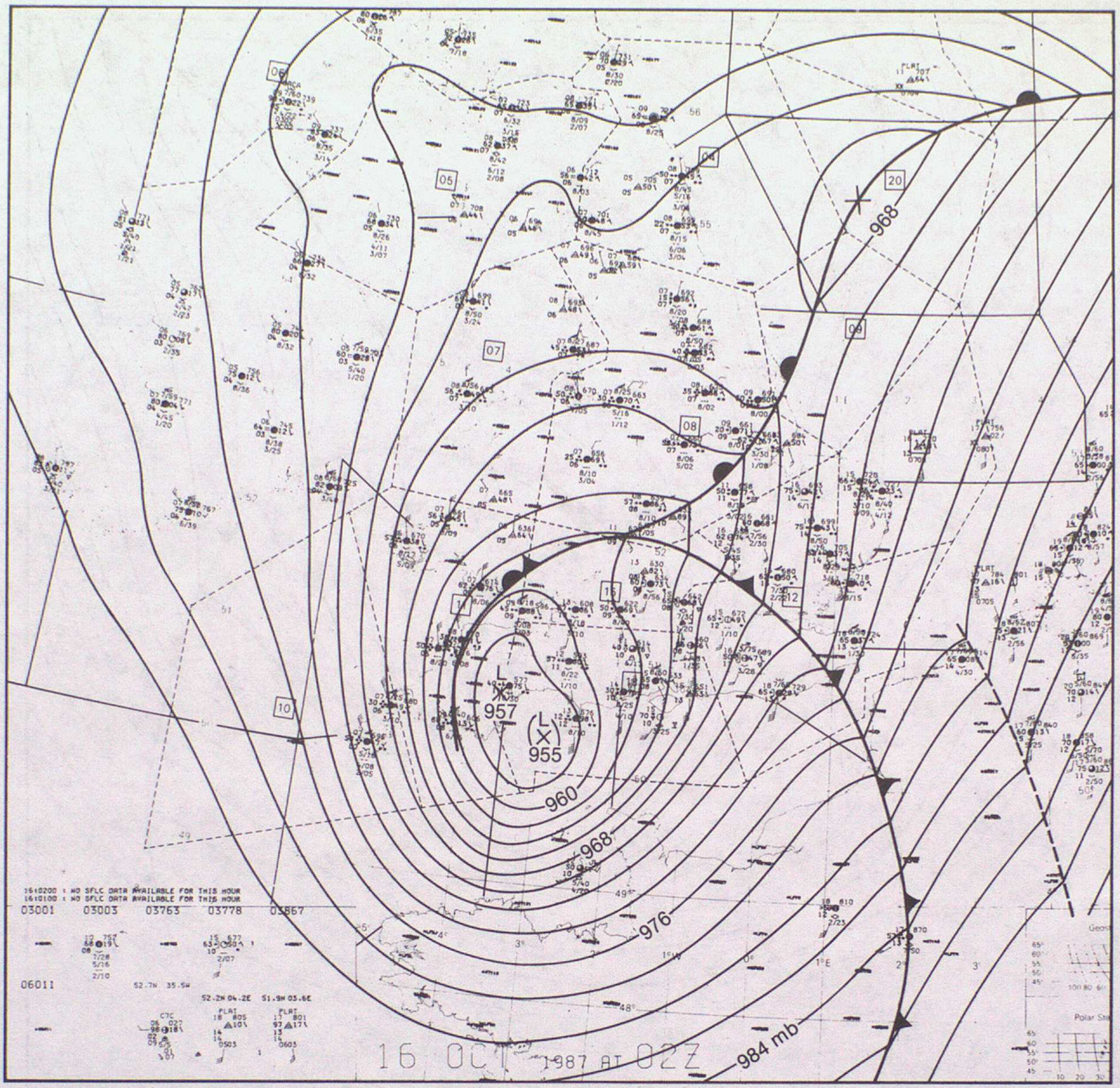

957
955
960
968
976
984 mb
968
16 OCT 1987 AT 02Z

Figure 1.6(c) UK surface analysis 0200 GMT 16 October 1987.

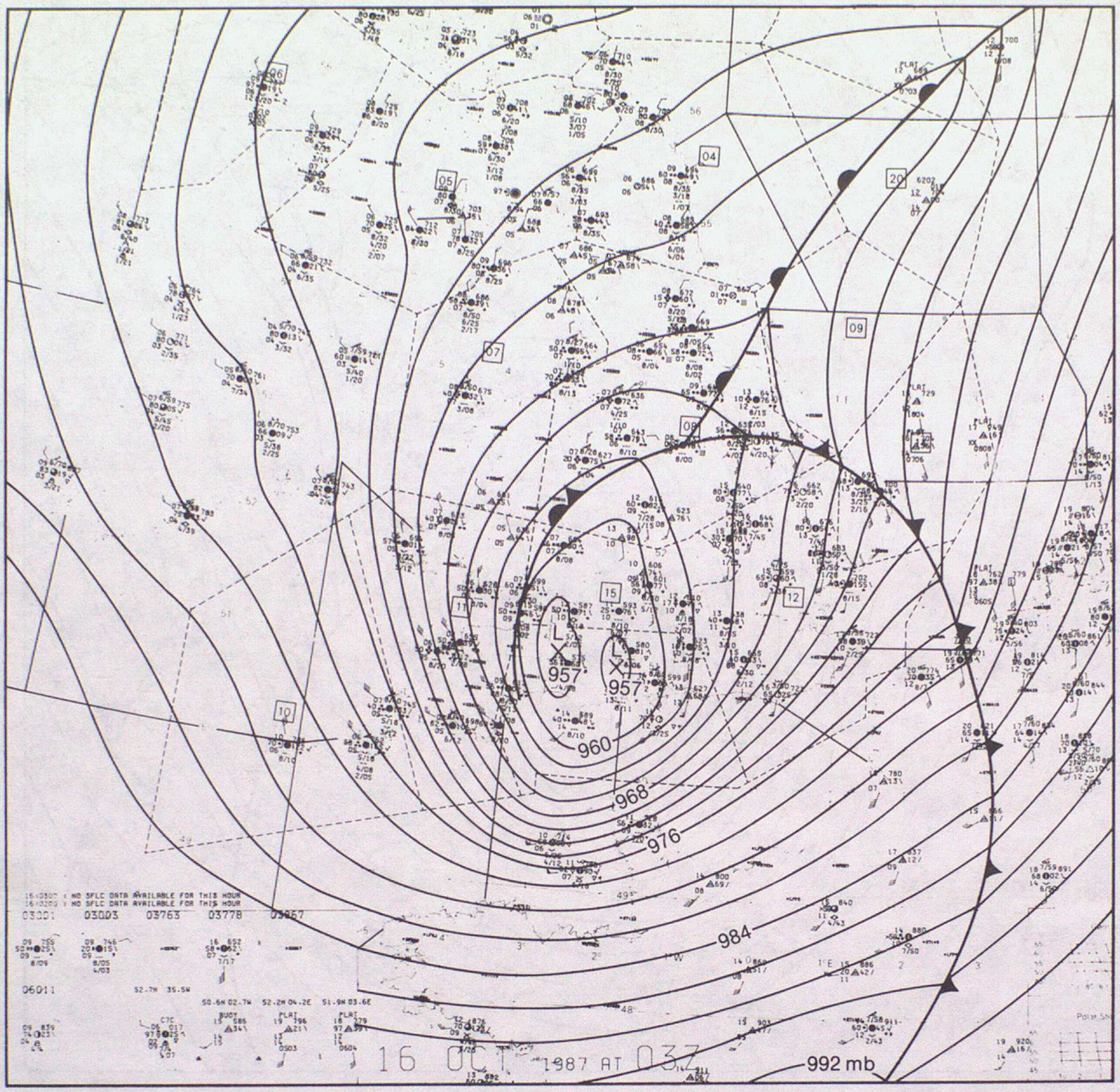

L
957
L
957
960
968
976
984
992 mb
16 OCT 1987 AT 03Z

Figure 1.6(d) UK surface analysis 0300 GMT 16 October 1987.

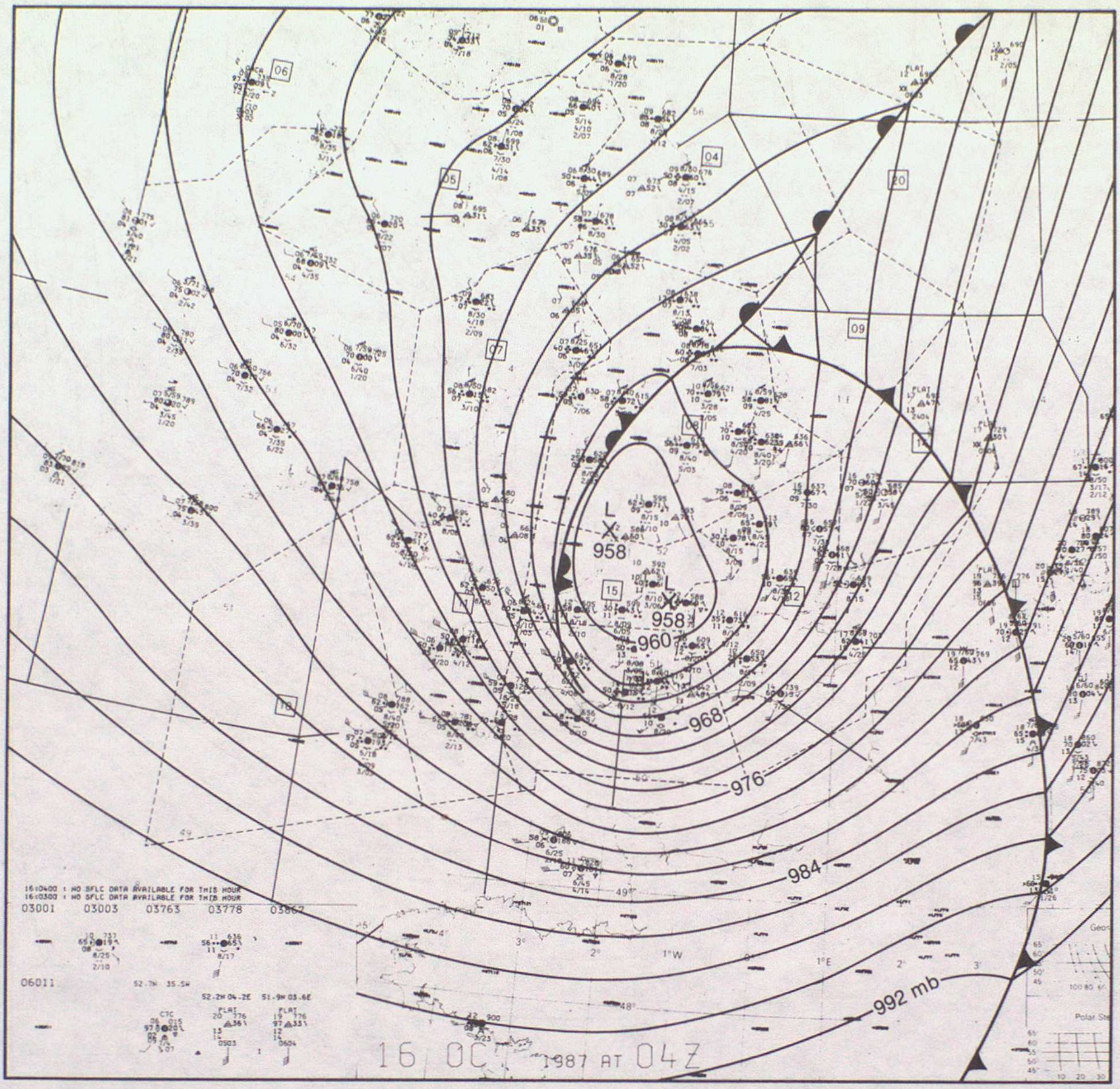

L
958
L
958
960
968
976
984
992 mb
16 OCT 1987 AT 04Z

Figure 1.6(e) UK surface analysis 0400 GMT 16 October 1987.

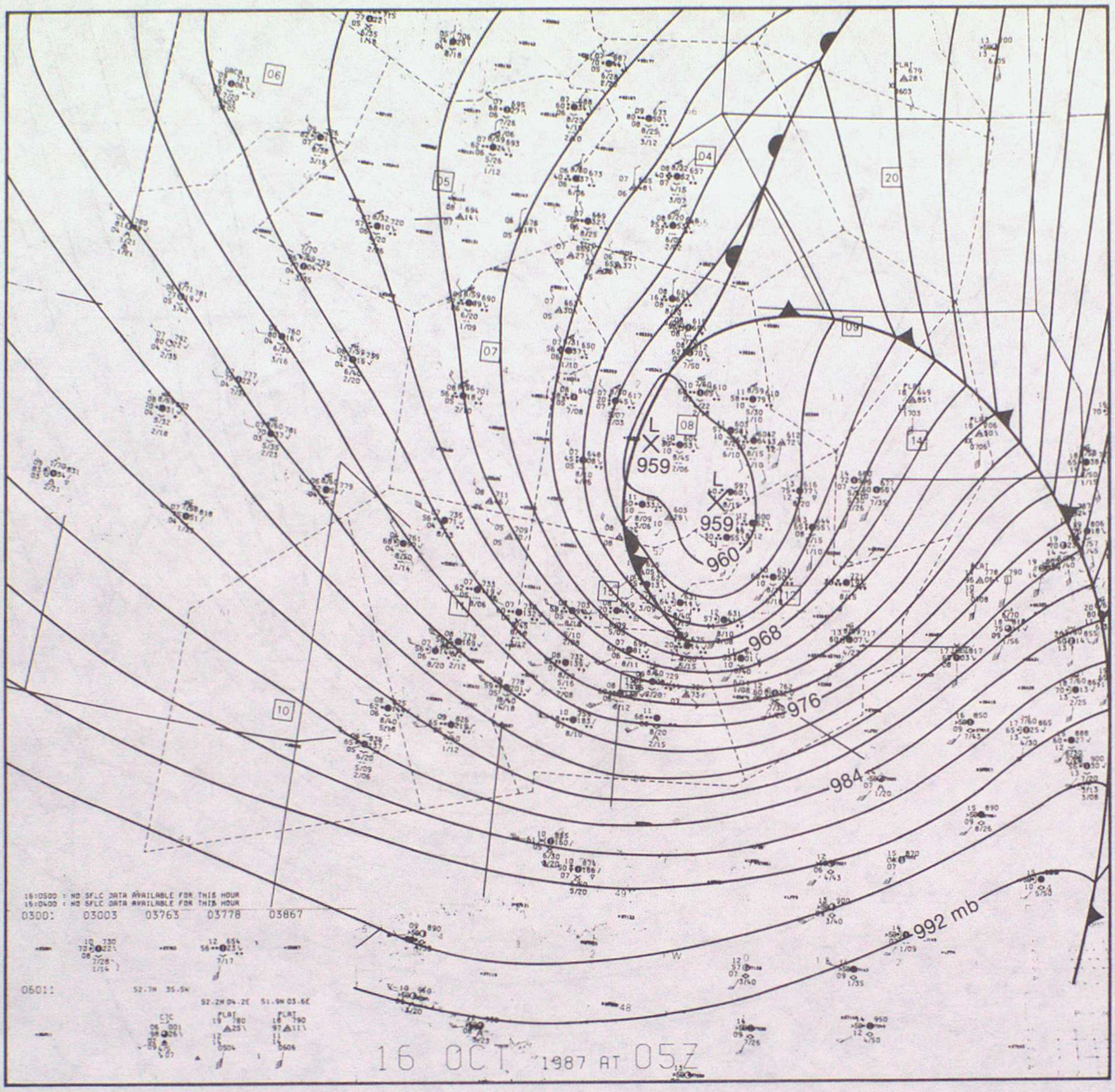

L
959
L
959
960
968
976
984
992 mb
06
05
04
20
07
08
09
14
10
16 OCT 1987 AT 05Z

Figure 1.6(f) UK surface analysis 0500 GMT 16 October 1987.

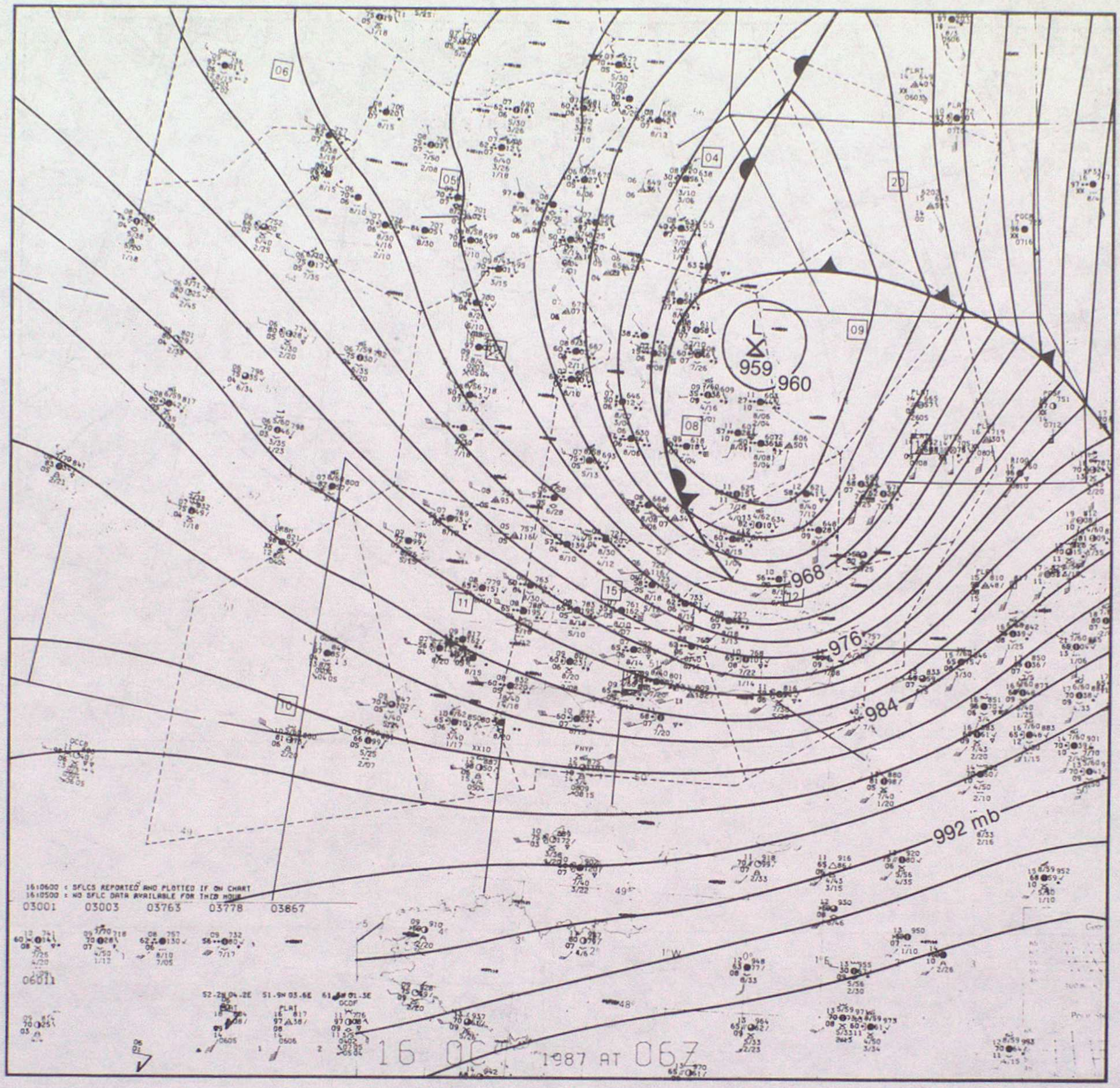

L
959
960
968
976
984
992 mb
16 OCT 1987 AT 06Z
03001
03003
03763
03778
03867
06011

Figure 1.6(g) UK surface analysis 0600 GMT 16 October 1987.

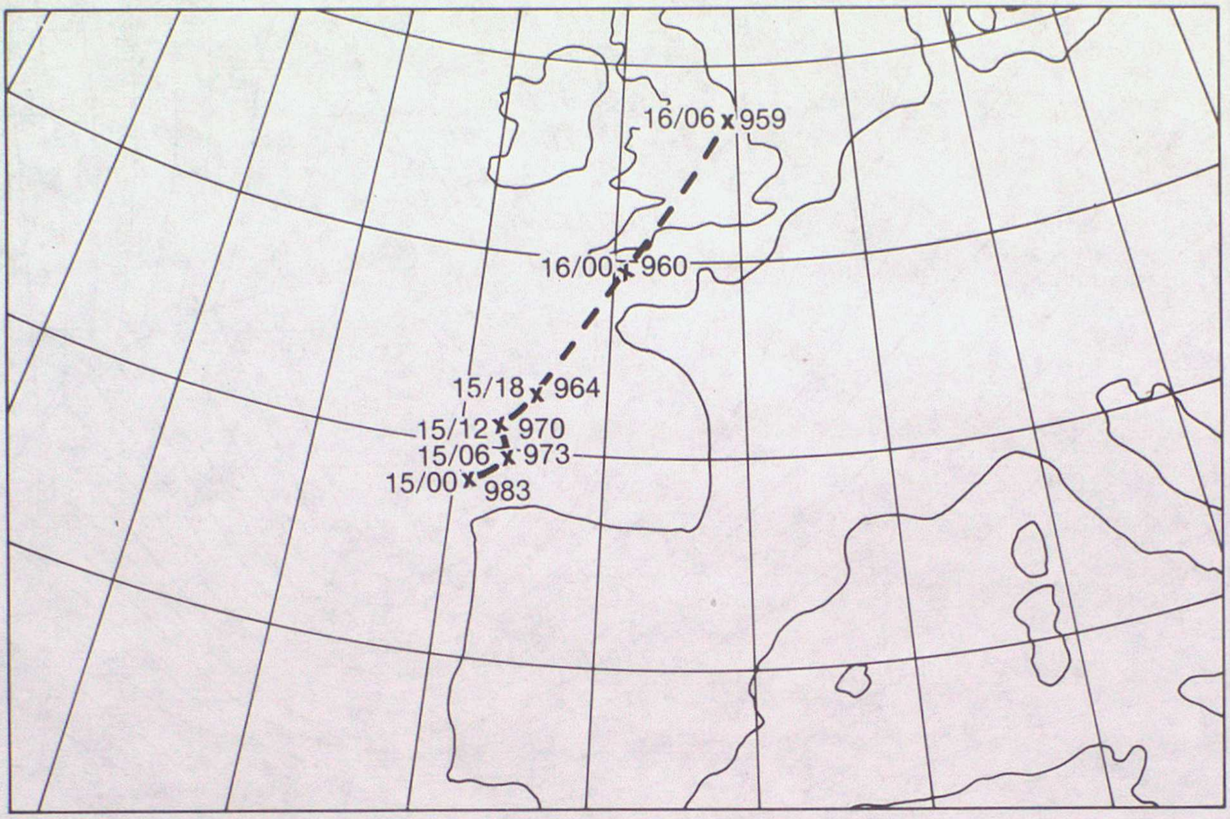

16/06 x 959
16/00 x 960
15/18 x 964
15/12 x 970
15/06 x 973
15/00 x 983

Figure 1.7(a) Storm track — operational analysis.

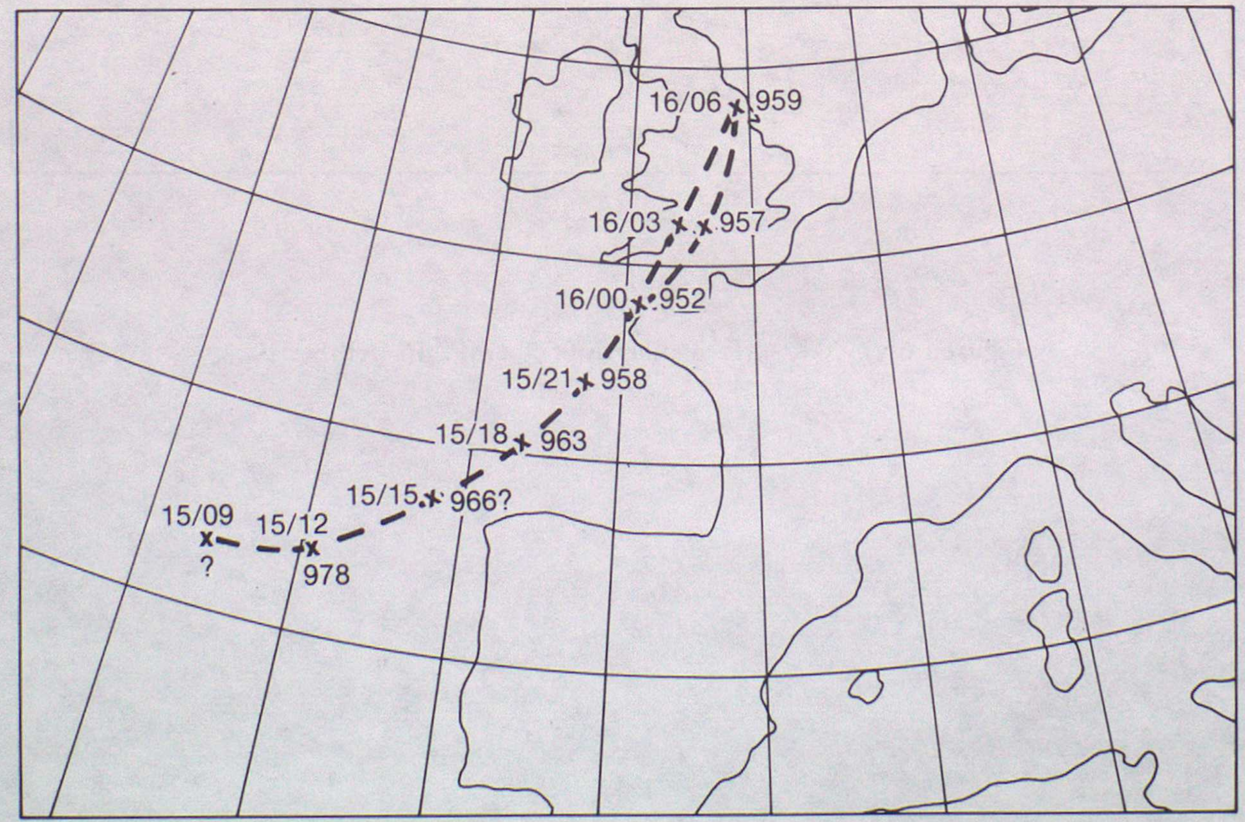

16/06 x 959
16/03 x x 957
16/00 x 952
15/21 x 958
15/18 x 963
15/15 x 966?
15/09 x ?
15/12 x 978

Figure 1.7(b) Storm track — finalized analysis.

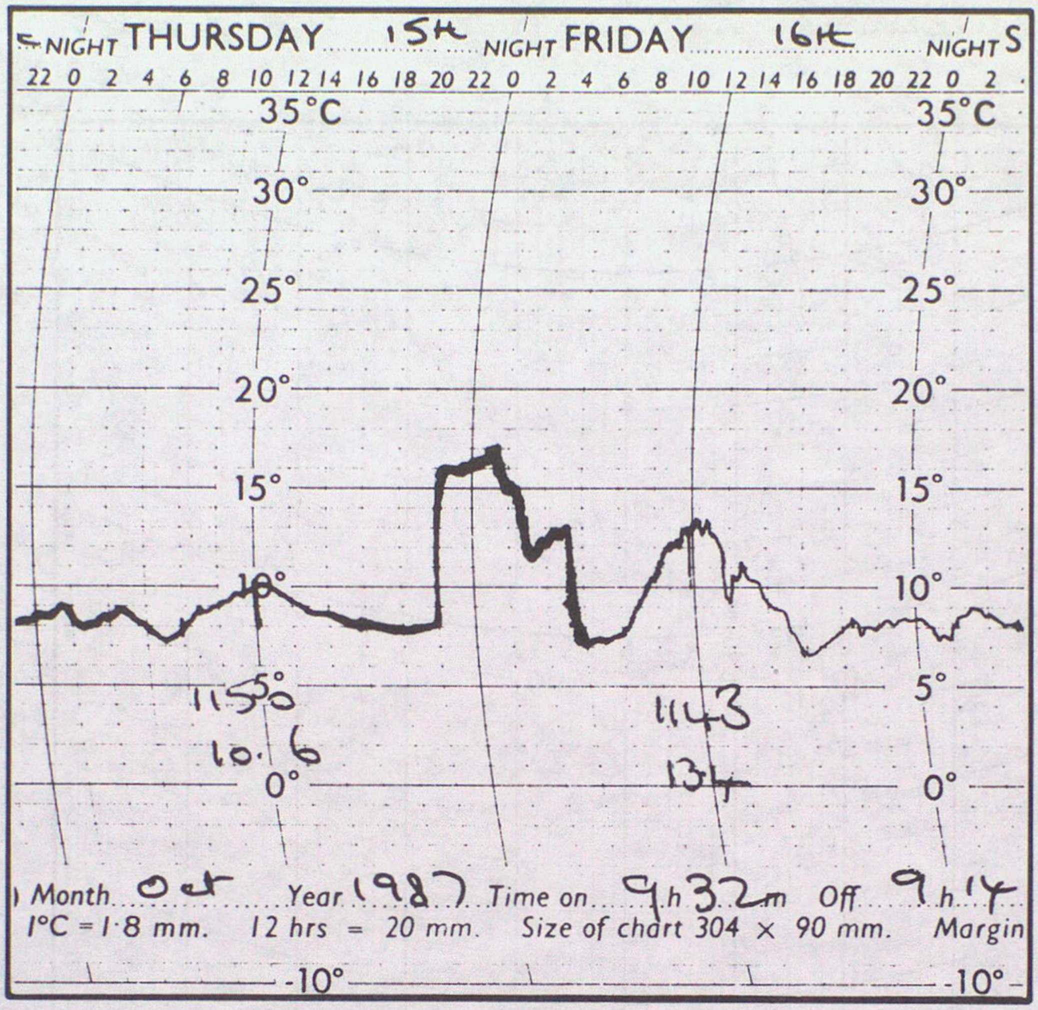


Figure 1.8 Thermogram from Bracknell for 15/16 October 1987.

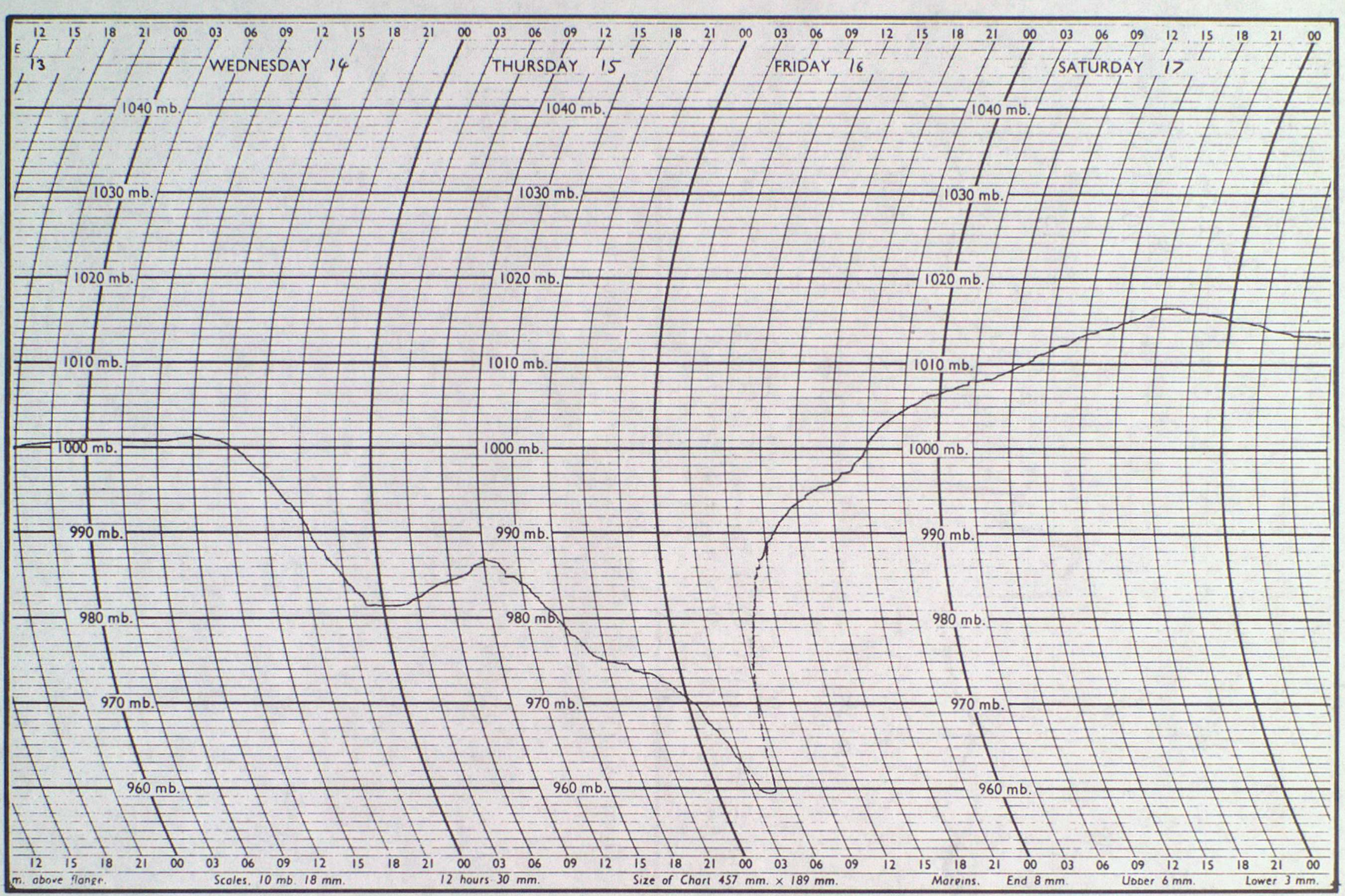


Figure 1.9 Barogram from Bracknell for 15/16 October 1987.

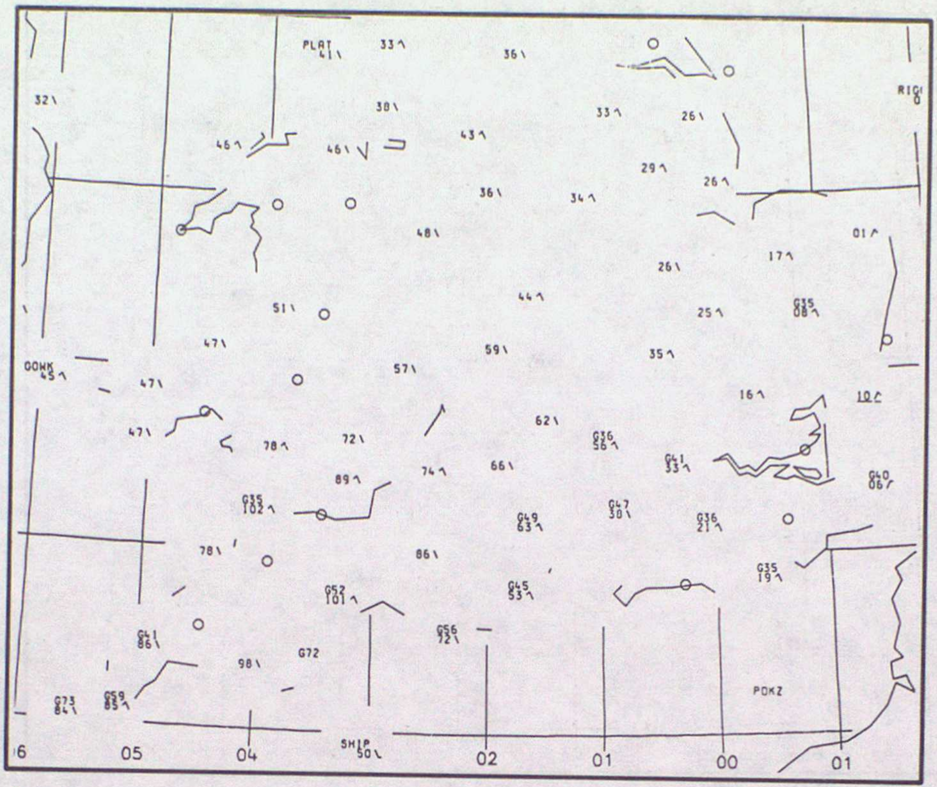

PLAT
RIC
GONK
SHIP
POKZ
6
05
04
02
01
00
01

Figure 1.10(a) Three-hourly pressure changes (in tenths of a mb) between 2100 on 15 October and 0000 GMT on 16 October 1987.

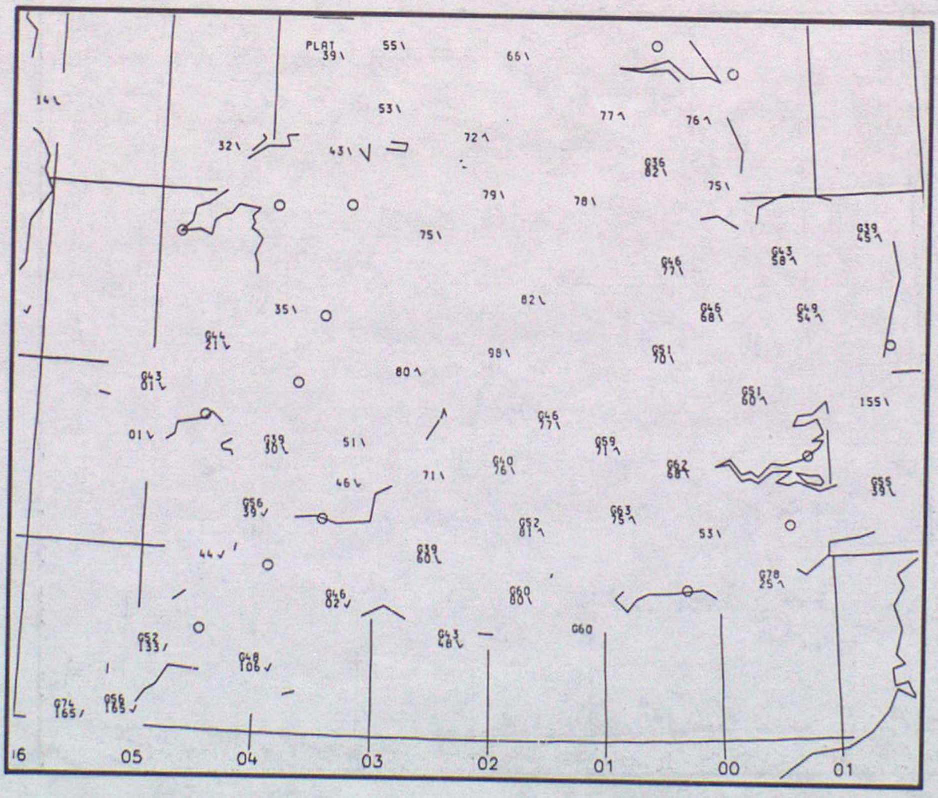

PLAT
6
05
04
03
02
01
00
01

Figure 1.10(b) Three-hourly pressure changes (in tenths of a mb) between 0000 and 0300 GMT on 16 October 1987.

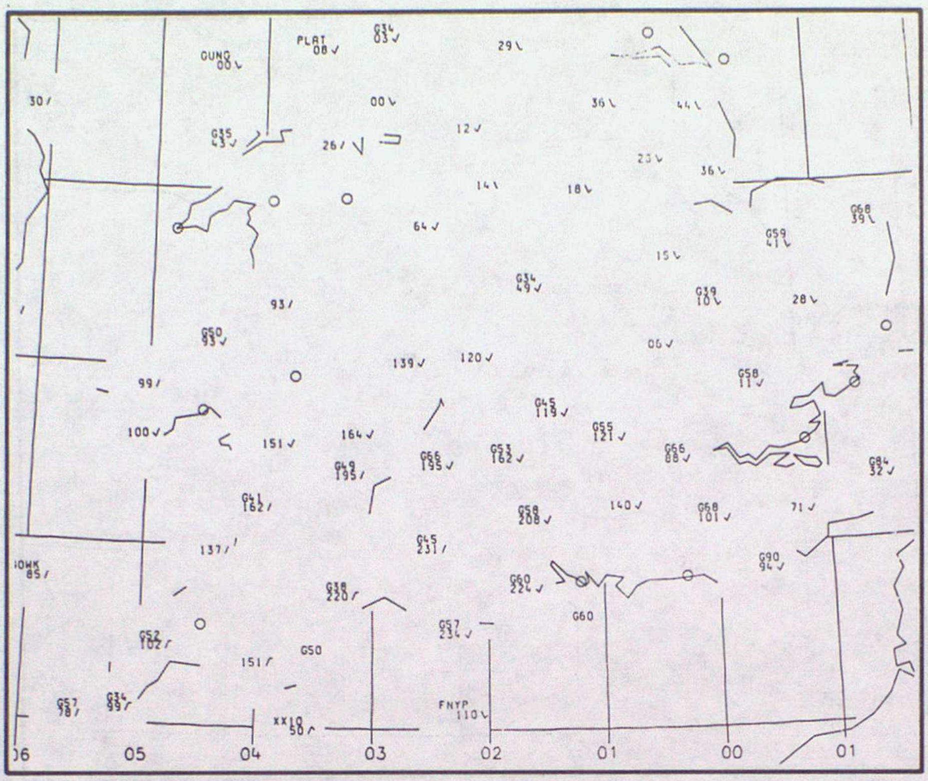

06
05
04
03
02
01
00
01

Figure 1.10(c) Three-hourly pressure changes (in tenths of a mb) between 0300 and 0600 GMT on 16 October 1987.

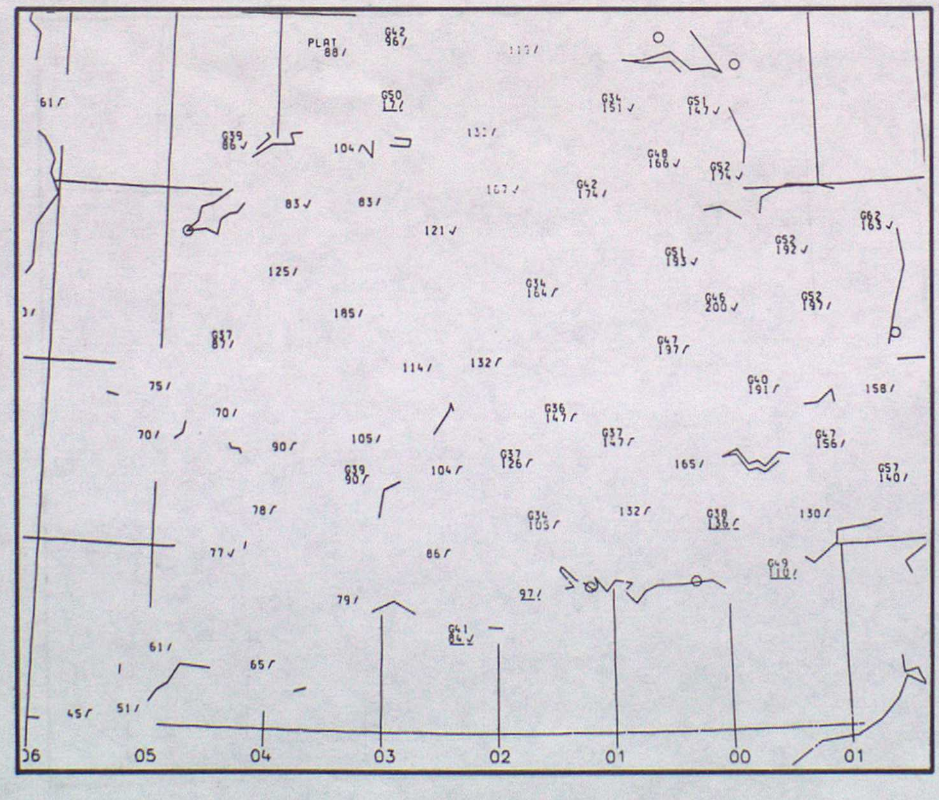

06
05
04
03
02
01
00
01

Figure 1.10(d) Three-hourly pressure changes (in tenths of a mb) between 0600 and 0900 GMT on 16 October 1987.

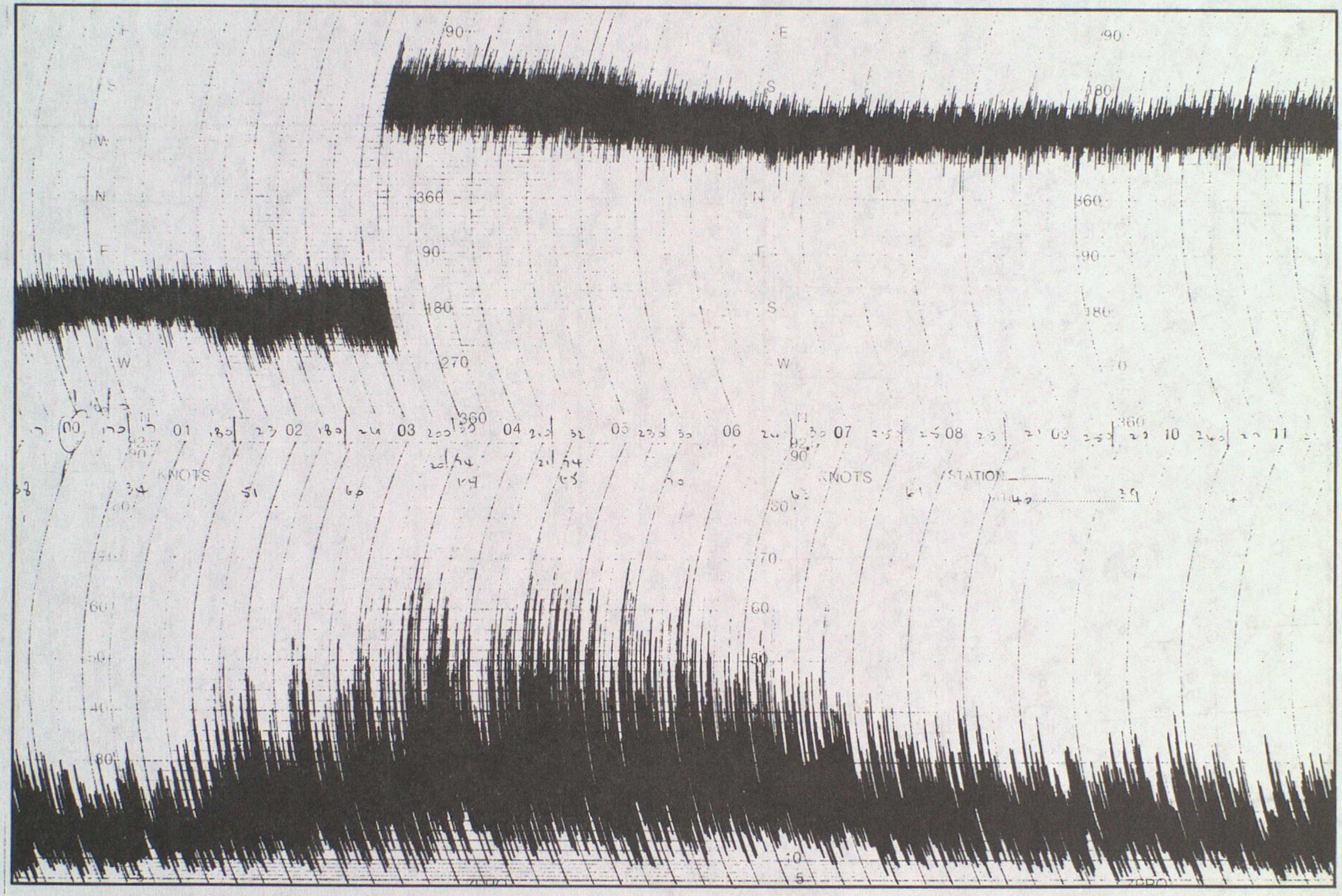


Figure 1.11 Anemogram from Gravesend for 15/16 October 1987; the upper trace gives the wind direction and the lower trace the wind speed.

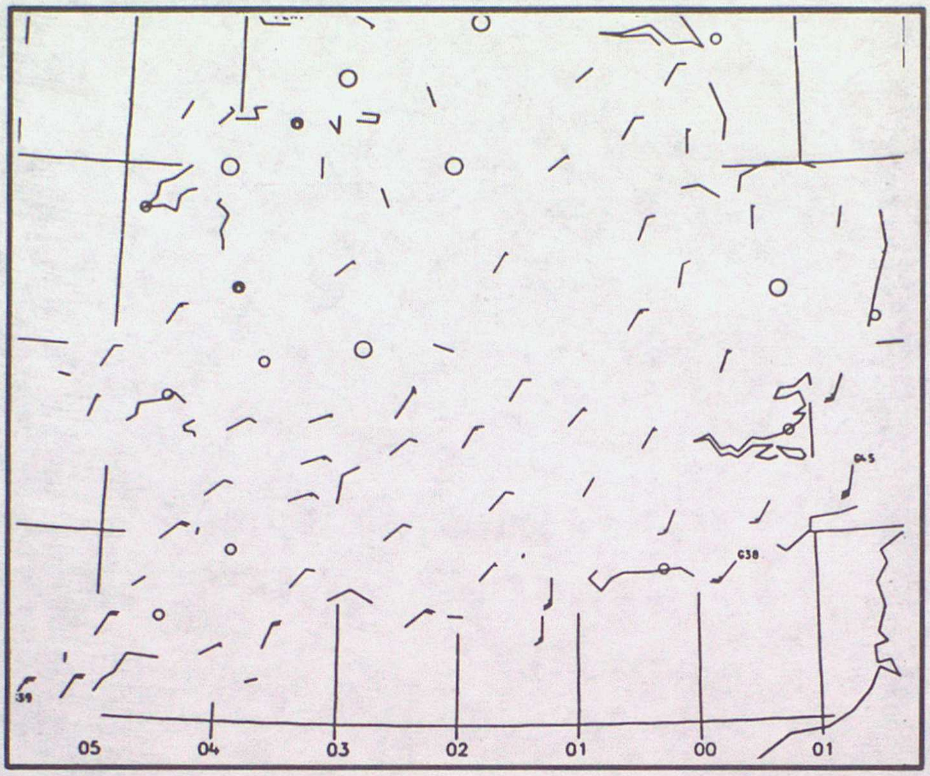

G45
G38
G39
05
04
03
02
01
00
01

Figure 1.12(a) Mean wind speeds and maximum gusts reported at 2100 GMT on 15 October 1987.

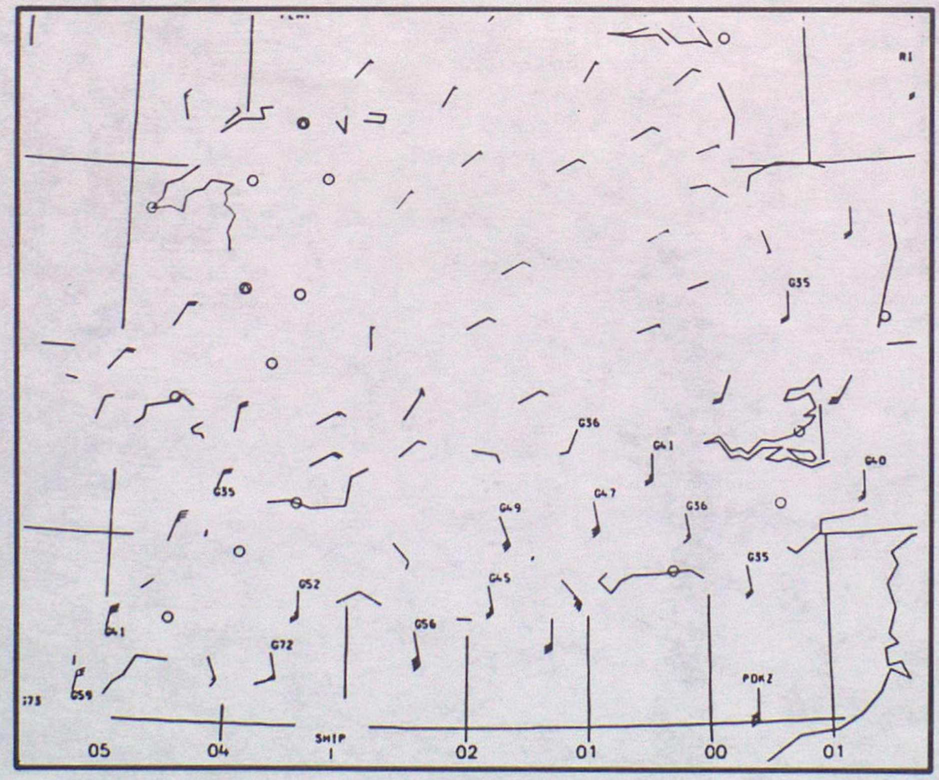

R1
G35
G36
G41
G40
G35
G49
G47
G36
G35
G52
G45
G56
G41
G72
G59
PDKZ
SHIP
05
04
1
02
01
00
01

Figure 1.12(b) Mean wind speeds and maximum gusts reported at 0000 GMT on 16 October 1987.

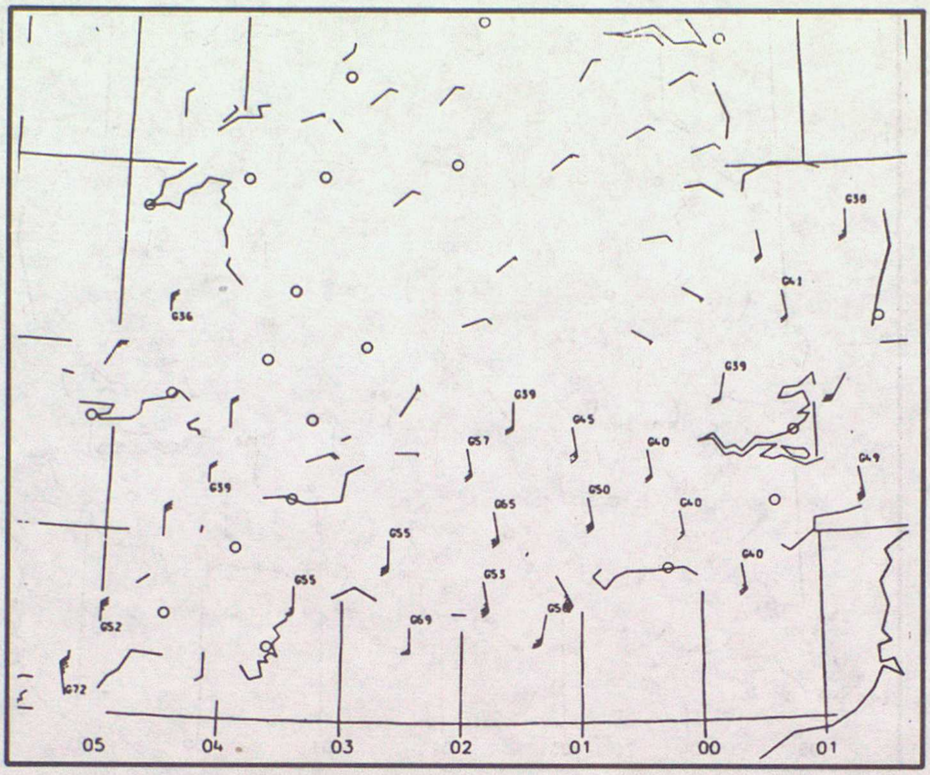

G38
G41
G36
G39
G39
G45
G57
G40
G49
G59
G65
G50
G40
G55
G40
G55
G53
G52
G69
G58
G72
05
04
03
02
01
00
01

Figure 1.12(c) Mean wind speeds and maximum gusts reported at 0100 GMT on 16 October 1987.

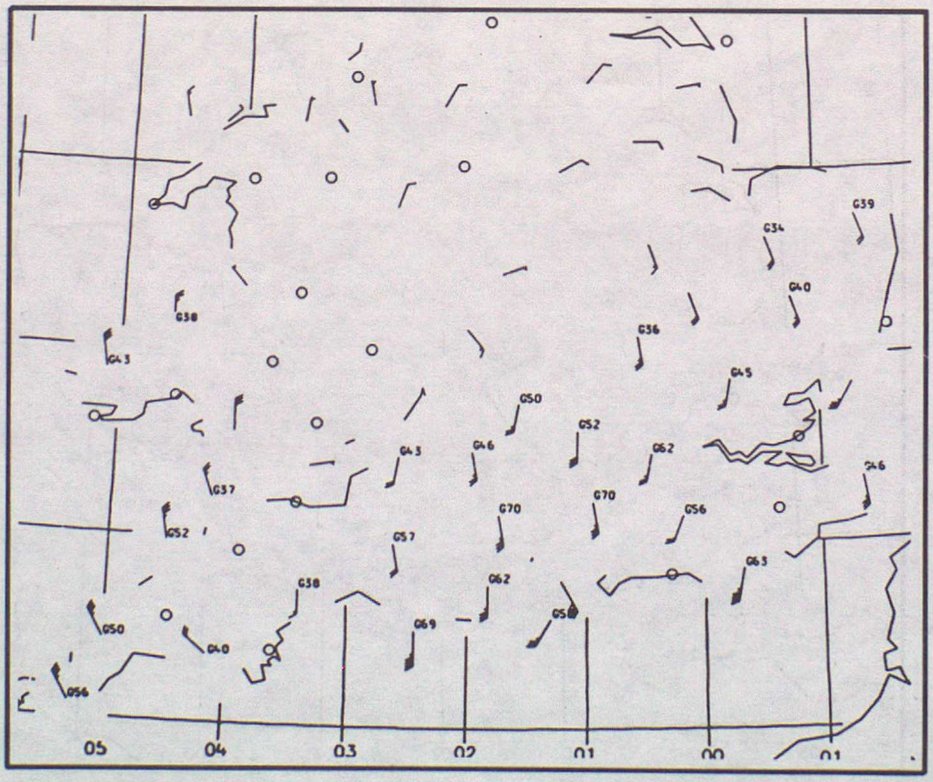

G39
G34
G40
G38
G43
G36
G45
G50
G52
G46
G43
G62
G46
G37
G70
G70
G56
G52
G57
G63
G38
G62
G50
G69
G58
G40
G56
05
04
03
02
01
00
01

Figure 1.12(d) Mean wind speeds and maximum gusts reported at 0200 GMT on 16 October 1987.

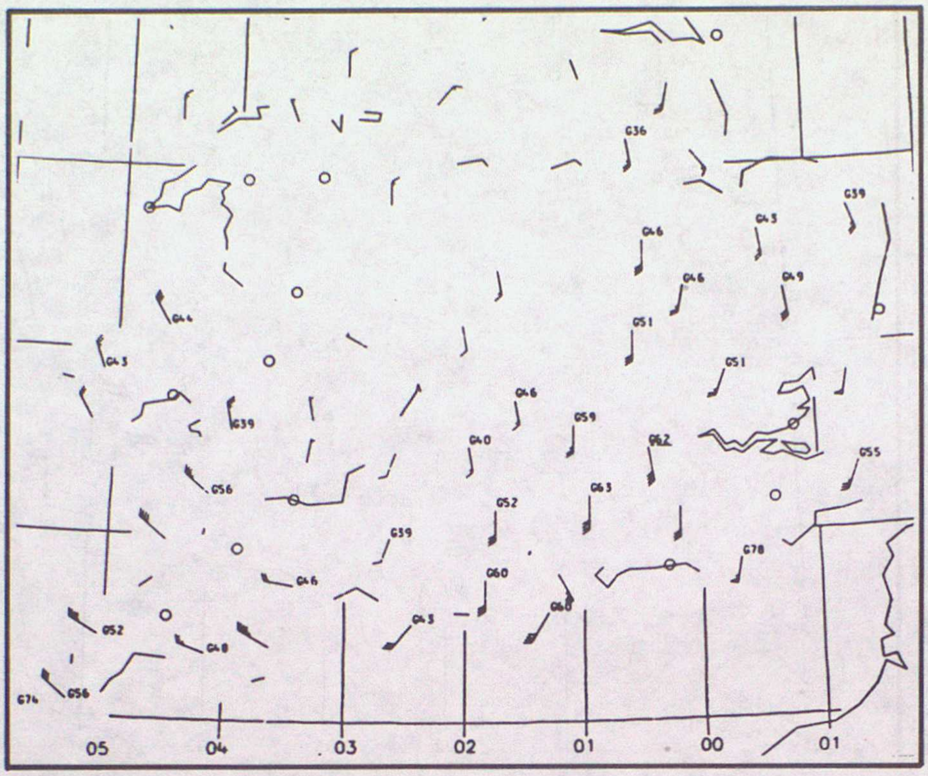

G36
G39
G46
G43
G46
G49
G44
G51
G43
G51
G46
G39
G59
G40
G62
G55
G56
G63
G52
G39
G78
G60
G46
G43
G68
G52
G48
G74
G56
05
04
03
02
01
00
01

Figure 1.12(e) Mean wind speeds and maximum gusts reported at 0300 GMT on 16 October 1987.

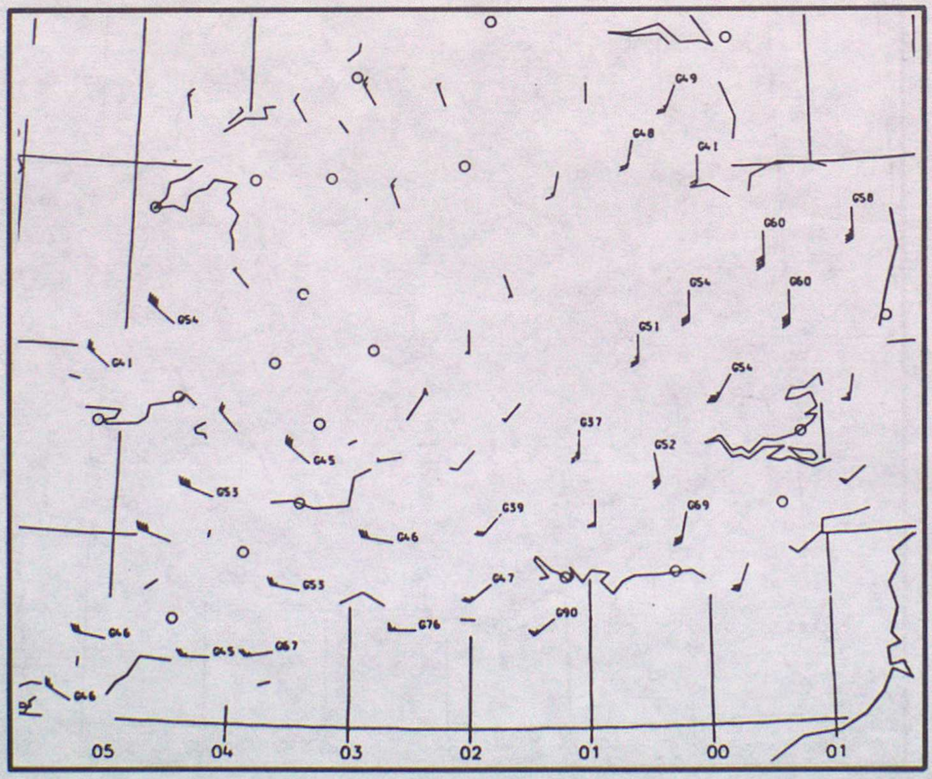

G49
G48
G41
G58
G60
G54
G60
G54
G51
G41
G54
G37
G45
G52
G53
G39
G69
G46
G53
G47
G90
G76
G46
G45
G67
G46
05
04
03
02
01
00
01

Figure 1.12(f) Mean wind speeds and maximum gusts reported at 0400 GMT on 16 October 1987.

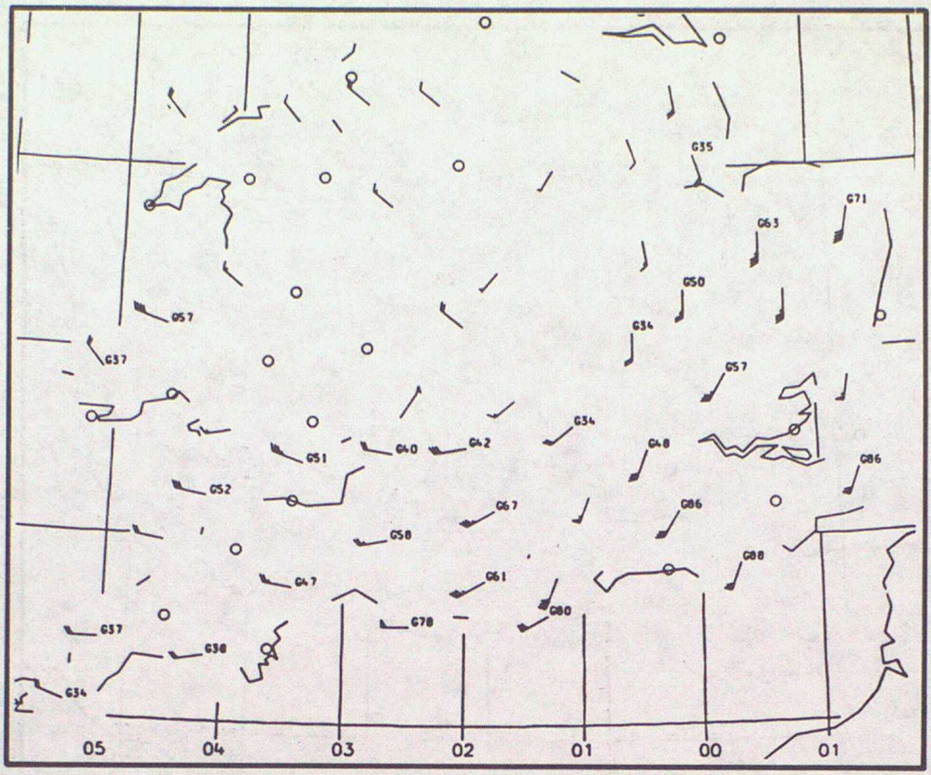

G35
G71
G63
G50
G57
G34
G37
G57
G34
G51
G40
G42
G48
G86
G52
G67
G86
G58
G88
G47
G61
G80
G37
G78
G38
G34
05
04
03
02
01
00
01

Figure 1.12(g) Mean wind speeds and maximum gusts reported at 0500 GMT on 16 October 1987.

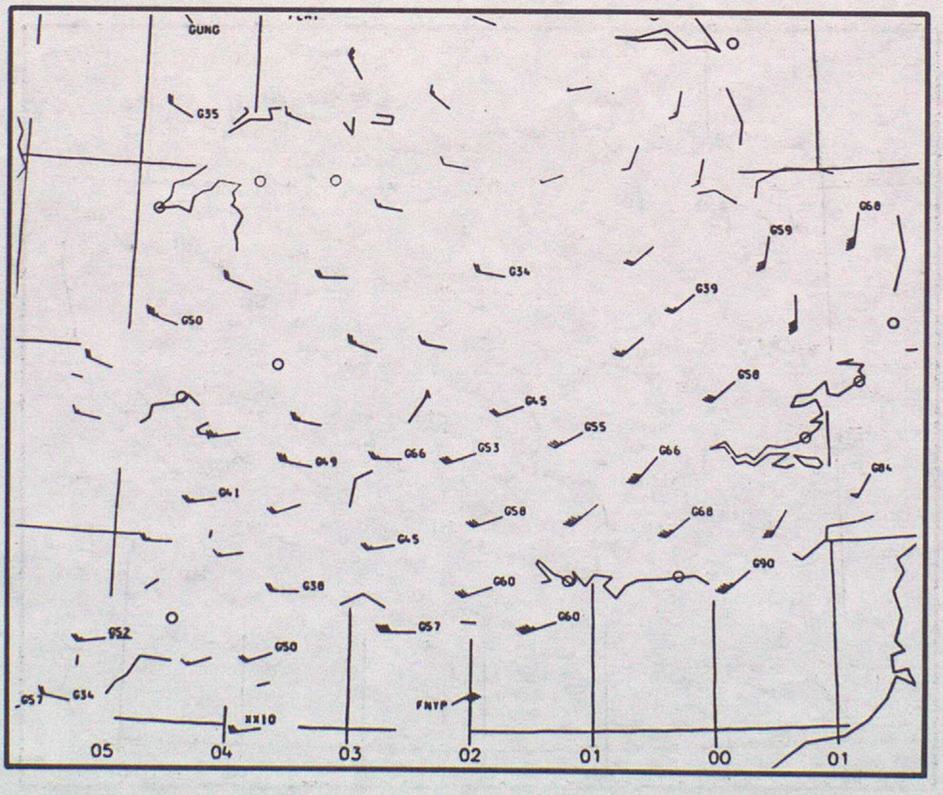

GUNG
G35
G68
G59
G34
G39
G50
G58
G45
G55
G49
G66
G53
G66
G84
G41
G58
G68
G45
G90
G38
G60
G57
G60
G52
G50
G57
G34
XX10
FNYP
05
04
03
02
01
00
01

Figure 1.12(h) Mean wind speeds and maximum gusts reported at 0600 GMT on 16 October 1987.

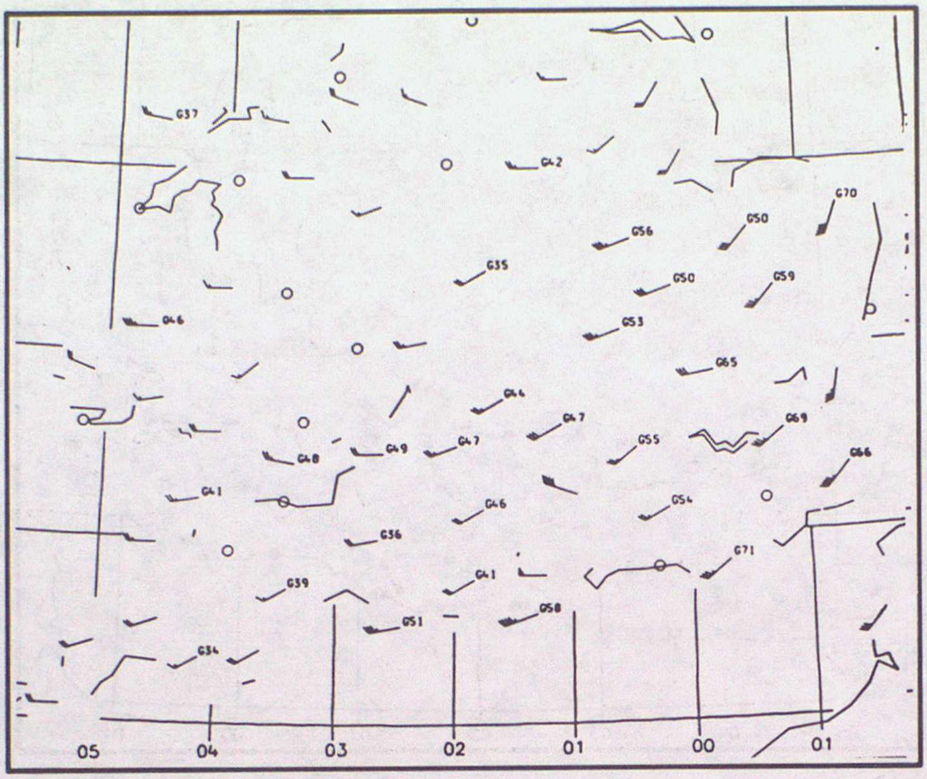

G37
G42
G70
G50
G56
G35
G50
G59
G46
G53
G65
G44
G47
G69
G49
G47
G55
G48
G66
G41
G46
G54
G36
G71
G39
G41
G58
G51
G34
05
04
03
02
01
00
01

Figure 1.12(i) Mean wind speeds and maximum gusts reported at 0700 GMT on 16 October 1987.

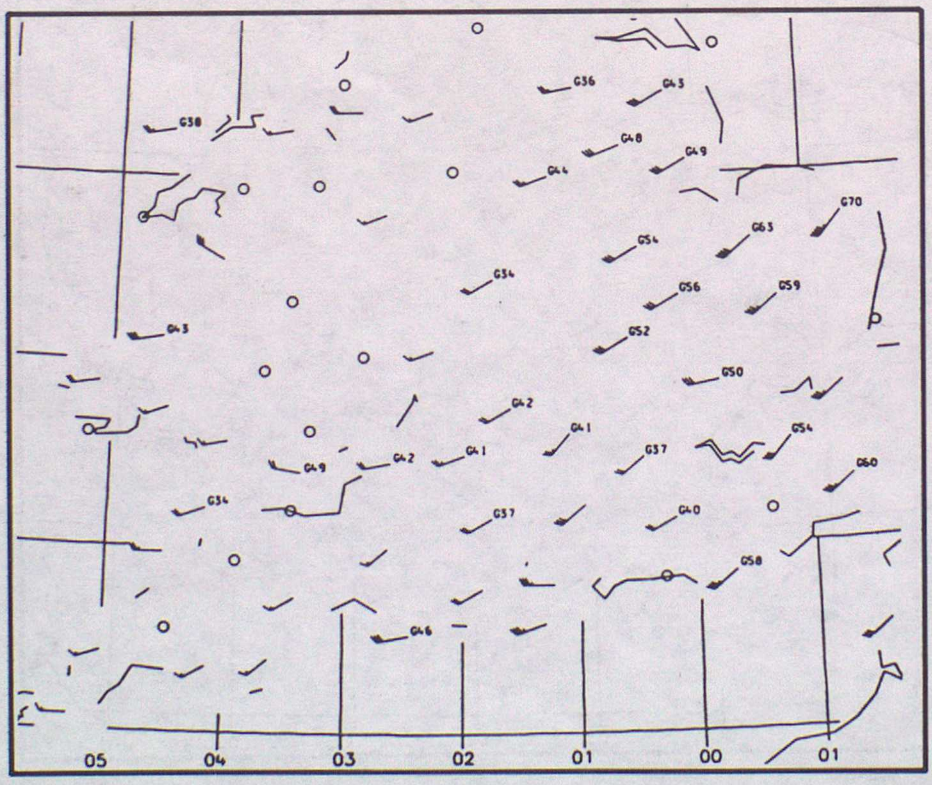

G36
G43
G38
G48
G49
G44
G70
G63
G54
G34
G56
G59
G43
G52
G50
G42
G41
G54
G37
G41
G42
G49
G60
G34
G37
G40
G58
G46
05
04
03
02
01
00
01

Figure 1.12(j) Mean wind speeds and maximum gusts reported at 0800 GMT on 16 October 1987.

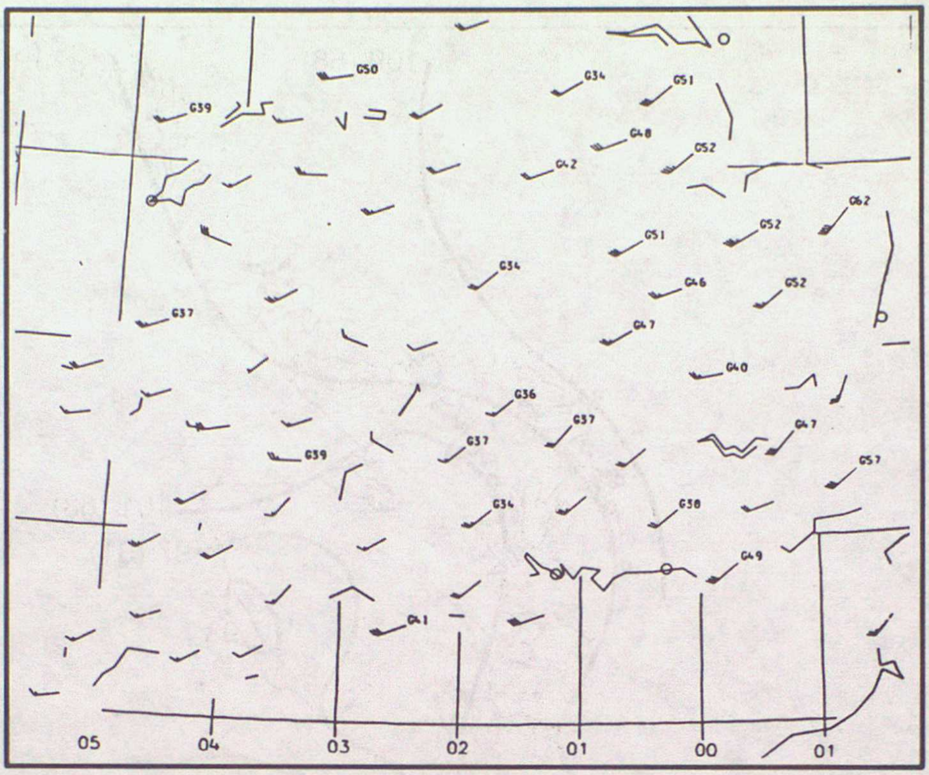

05
04
03
02
01
00
01

Figure 1.12(k) Mean wind speeds and maximum gusts reported at 0900 GMT on 16 October 1987.

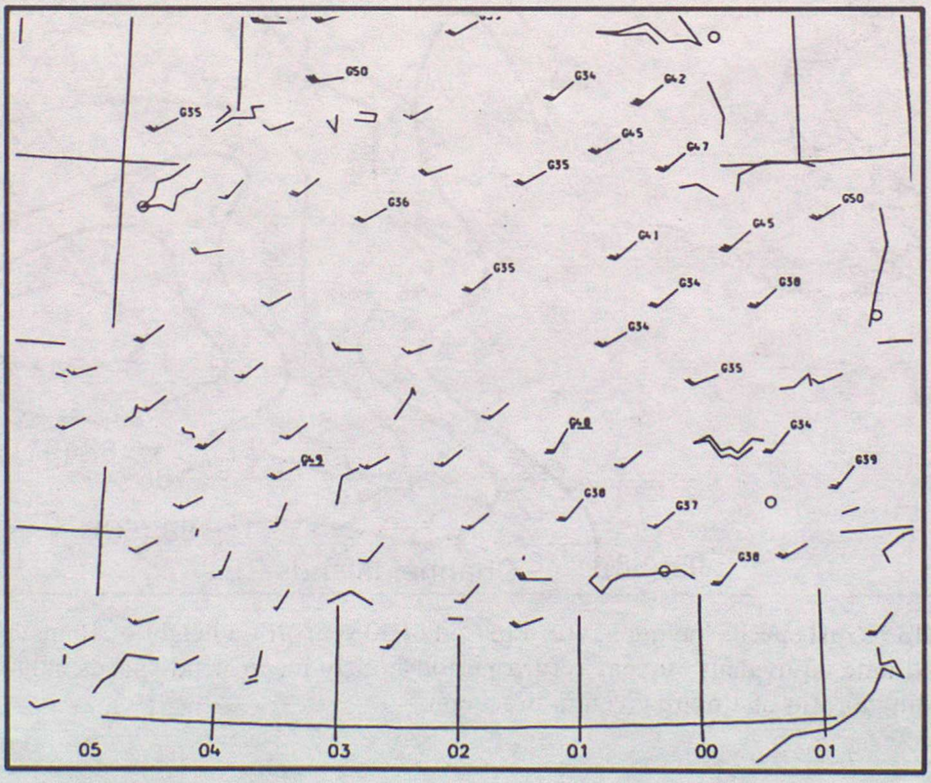

05
04
03
02
01
00
01

Figure 1.12(l) Mean wind speeds and maximum gusts reported at 1200 GMT on 16 October 1987.

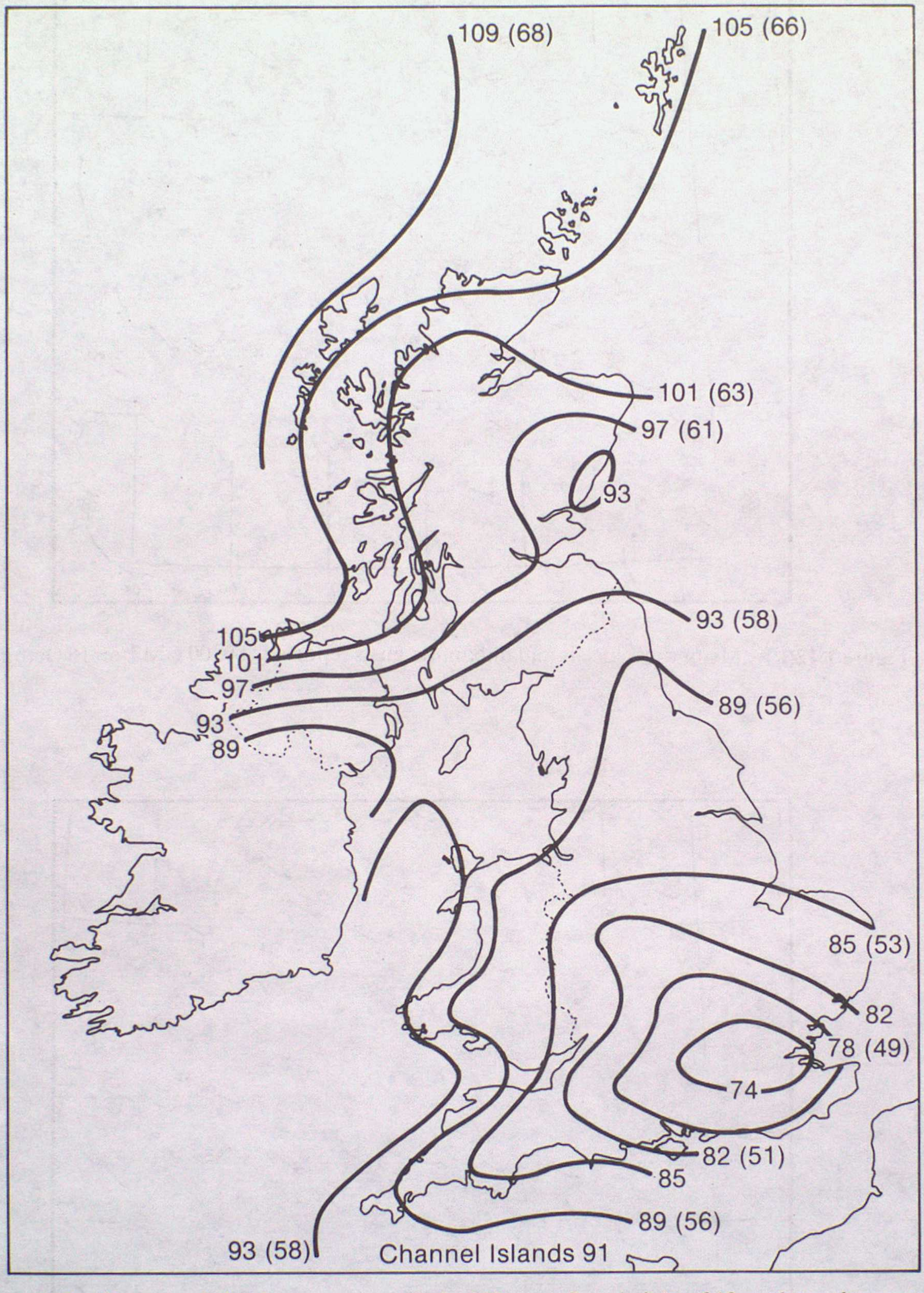

109 (68)
105 (66)
101 (63)
97 (61)
93
93 (58)
89 (56)
105
101
97
93
89
85 (53)
82
78 (49)
74
82 (51)
85
89 (56)
93 (58)
Channel Islands 91

Figure 1.13 Gust speeds having a return period of 50 years for a height of 10 m above the ground (approximate equivalent 50-year return period hourly-mean wind speeds calculated from the gusts using a ratio of 1.6 are given in brackets).

Chapter 2

THE NWP GUIDANCE AVAILABLE AT BRACKNELL, AND THE FORECASTERS' CONCLUSIONS AT THE TIME

2.1 Relevant NWP models

Forecasters in the Central Forecasting Office (CFO) at Bracknell are provided routinely with guidance from the following numerical weather prediction (NWP) models.

(a) The UK fine-mesh regional model
(b) The UK global model
(c) The ECMWF model
(d) The US global model

The two UK models are run on the Cyber 205 computer within the COSMOS computing complex at Bracknell. The European Centre for Medium-range Weather Forecasts (ECMWF) model is run on a Cray X-MP/48 computer at Reading. The US global model is used in two runs, one denoted by AVN (aviation) and the other by MRF (medium-range forecast), on Cyber 205 computers in Washington.

Certain important characteristics of the NWP guidance are summarized in the table below. The information is given separately for guidance based on 0000 GMT and 1200 GMT starting conditions, and includes the *length* of the numerical forecast in days, the *cut-off* time for observations used to establish the starting conditions, and the time at which the numerical products become *available* in CFO.

Model	Guidance from 0000 GMT			Guidance from 1200 GMT		
	Length (days)	Cut-off (GMT)	Available (GMT)	Length (days)	Cut-off (GMT)	Available (GMT)
UK fine mesh	1.5	0200	0300	1.5	1400	1500
UK global	6	0320	0500	6	1520	1700
ECMWF	—	—	—	10	1930	0200–0500
US AVN	3	0345	0830–1000	3	1545	2030–2200
US MRF	10	0600	1200	—	—	—

Numerical products could also be made available from NWP models run in France and the Federal Republic of Germany. These are not used routinely at present, but some comments on guidance from the French model are included below.

During the period leading up to the storm of 15/16 October, the routine NWP guidance was available without any significant delays, and the operational work on COSMOS was run according to schedule. Some delays did occur in the early hours of Friday 16 October as a result of disturbances in the power supplies to the computers, but of course these did not affect the production of guidance in advance of the storm. Fortunately these delays were not prolonged, and did not impair the forecasters' ability to provide accurate advice during the immediate aftermath, as the storm moved away.

2.2 Medium-range NWP guidance

The medium range of forecasting is defined by the World Meteorological Organization as 'more than 72 hours ahead and up to 10 days'. The ECMWF and the US MRF numerical forecasts are designed specifically for this purpose. Hence they need to be run only once daily, and they use late data-cut-off times to ensure that important observations are not missed. The UK global numerical forecasts are designed primarily for short-range forecasting purposes. Hence, like the US AVN forecasts, they are run twice daily with a relatively early cut-off. The UK global forecasts are, however, extended to 6 days ahead to provide additional guidance for the early medium range.

The medium-range NWP guidance for the onset of the storm was generally good. It must be borne in mind that precision is not attainable in the medium range, so the guidance is judged according to whether or not it indicates the correct general weather conditions. For example, a numerical forecast may give the wrong relative emphasis to two or more depressions moving in rapid sequence along similar tracks; this will lead to modest timing errors, but the quality of the medium-range guidance remains good.

Although it is the sequence of forecast guidance from each model run that is important in practice, for the purposes of this report attention is focussed on numerical forecasts valid at 0000 GMT 16 October. At this time the storm was fully developed at 952 mb in the English Channel, and the onset over southern England was imminent.

Figures 2.1, 2.2 and 2.3 show the forecast locations of the storm at this time and tabulate the values of mean-sea-level pressure at the storm centre according to the numerical forecasts from the UK global model, the ECMWF model and the US global model respectively. For convenience the complete sets of forecasts, including the short-range forecasts, are given in these figures.

The medium-range guidance from the UK global model was more consistent than that from either of the other two models. It was also more accurate, particularly with regard to the track of the storm, though it showed a slight systematic error in moving the storm across the British Isles a few hours too early.

These points are brought out by Figures 2.4 and 2.5, which show the sequence of NWP guidance from the three models in the order it became available in CFO during the evening of Sunday 11 October and the morning of Monday 12 October. The two UK forecasts (108 and 96 hours ahead) are consistent in showing a deep depression, 968 mb and 967 mb respectively, centred over the Irish Sea and Lancashire respectively, with very strong winds implied by the pressure gradients over southern and eastern England.

The corresponding ECMWF (108 hours ahead) and US (96 hours ahead) forecasts both keep the storm well south and west of Ireland at this stage. As a consequence they retain an older low as a separate feature north of Scotland, whereas in the UK forecasts this has merged with the storm circulation leaving only troughing of the pattern. The ECMWF forecast shows a vigorous low, with central pressure 965 mb, but the US forecast has the added disadvantage of indicating a less intense system, with central pressure 977 mb.

The medium-range forecasters in CFO accepted the NWP guidance, leaning towards the UK model in view of its consistency at 12-hourly intervals, with the result that forecasts issued from Sunday 11 October onwards emphasized the expected storm, timing its arrival for late on Thursday 15 October.

2.3 NWP guidance 72–48 hours ahead

The 72- and 60-hour numerical forecasts from the UK global model had slightly larger timing errors than the longer period UK forecasts, and took the centre out over the North Sea by 0000 GMT 16 October. The 48-hour UK forecast for this time gave a more accurate location, but unfortunately the central pressure was 976 mb compared with a range 960–968 mb for the previous five UK forecasts (see Figure 2.1).

The ECMWF 60-hour forecast persisted with a location south and west of Ireland. However, it improved on earlier guidance by taking the central pressure down to 954 mb (see Figure 2.2).

The US 72-hour forecast gave a location only slightly more accurate than the US 96-hour forecast, but the location from the US 48-hour forecast was considerably better and the most accurate produced up to that stage. Both the 72- and the 48-hour US forecasts continued to underplay the intensity of the low, with central pressures of 976 mb and 978 mb respectively (see Figure 2.3).

The NWP guidance during this period did not give a clear message, and the forecasters were left uncertain as to the likely track, timing and intensity of the low-pressure system. The UK model had switched its story towards a shallower feature, tracking further east, and the threat of very strong winds over UK land areas seemed to have diminished somewhat.

2.4 NWP guidance up to 36 hours ahead

During the final 36 hours leading up to the onset of the storm, additional NWP guidance became available from the UK fine-mesh model. Senior forecasters in CFO rely heavily on this model when preparing 24-hour prognostic charts, which they do at 6-hourly intervals, though the results from the UK global model are also available in time to be considered.

The NWP guidance for 0000 GMT 16 October from 36-, 24- and 12-hour forecasts is shown in Figures 2.6, 2.7 and 2.8 respectively. The 36- and 12-hour forecasts from the ECMWF model are included for interest, though of course they are not available in time to be directly useful for short-range forecasting. Sequences from two of the fine-mesh runs are shown in Figures 2.9 and 2.10 to illustrate the guidance on the storm track.

All three 36-hour forecasts are poor. The UK fine-mesh model and the ECMWF model both failed completely to develop a storm, and the main centre shown in both forecasts is the older low near the north of Scotland. The fine-mesh model has run a shallow feature (977 mb) forward over the North Sea. The ECMWF model has a very weak secondary centre (985 mb) near Brest. This is close to the position of the storm, but with errors in excess of 30 mb the implied winds are very light (around 10 kn) over the English Channel, southern England and northern France.

The 36-hour forecast from the UK global model is only a little better, with a 974 mb centre over East Anglia. This advantage is sufficient, however, to retain strong pressure gradients and implied strong winds over northern France and the Low Countries.

The 24-hour fine-mesh forecast maintains the idea of a low centre crossing south-east England to a position over the North Sea, but the feature is now considerably deeper (967 mb) than in the 36-hour forecast. This particular track and timing are quite similar to those of the low that preceded the storm itself (see the discussion in chapter 1). A possible interpretation, then, is that this run of the fine-mesh model handled the first low well but completely missed the next baroclinic wave that developed into the storm. The accurate handling of the first low may have tended to confirm the perceived accuracy of this fine-mesh evolution as a whole, since the crucial wave developed in a data-sparse area and remained undetected for a time.

The 24-hour forecast from the UK global model stands out from all the previous guidance and places a 965 mb centre (i.e. 13 mb in error) near the south Devon coast. This proved to be the first NWP guidance that was reasonably accurate for *both* the location and the intensity of the storm. The 30-hour forecast from the same run (included in Figure 2.7) is also accurate, showing the storm centre positioned just off the east coast of England by 0600 GMT 16 October.

Comparing the global and fine-mesh 24-hour forecasts, and continuing the line of interpretation suggested above, it is probable that this run of the global model failed to capture the first low. Certainly the forecast shows no sign of the troughing into the North Sea that should be present at 0000 GMT 16 October. More significantly as it turned out, the run seems to have succeeded in developing a baroclinic wave rapidly in about the right position to give accurate guidance on the storm onset.

Disappointingly, none of the 12-hour forecasts are as accurate as the 24-hour forecast from the global model. All three models moved centres along reasonably accurate tracks but with timing errors of around 4 hours in 12. The fine-mesh model was the most successful of the three, with a centre of 963 mb.

It is noteworthy that all of the 24- and 12-hour forecasts, despite other faults to varying degrees, maintain the belt of strong pressure gradients and implied strong winds across northern France and the Low Countries, and over adjacent sea areas.

2.5 Note on the US and French 24-hour forecasts

It is perhaps significant that the US global model and the French hemispheric model ('Emeraude') both also gave 24-hour forecasts of useful quality for 0000 GMT 16 October. (Note however that neither of these products was used in CFO. The US 24-hour product arrives too late to be used. The Emeraude products are not at present provided operationally to CFO, though the data are received routinely from Paris for back-up purposes.)

Both these 24-hour forecasts were a little more accurate in locating the centre of the storm but less accurate in forecasting its intensity when compared with the 24-hour forecast from the UK global model. By coincidence both placed the centre close to Brest with central pressures of 973 mb, i.e. 21 mb in error.

2.6 Direct NWP guidance on surface winds

For convenience the above assessments of the NWP guidance have been based on mean-sea-level pressure patterns. Surface wind guidance is provided by the pressure gradients, but naturally there is interest also in direct NWP guidance on surface winds. Clearly, when the pressure pattern is wrongly forecast the winds will be wrong too, so attention is focussed here on examples where the forecasts of the pressure pattern were reasonably accurate. It should be stressed that the NWP guidance refers to mean surface winds, not to gusts.

Comparison of surface-wind forecasts requires caution since the choice is sometimes made to display winds from the lowest model level (about 25 m above the surface in the case of the UK models) whilst in other cases a calculation is made of the winds implied at a standard near-surface level, usually 10 m. Complications also arise regarding the deceleration of the wind by frictional effects, these being much greater over land than over the sea and dependent on assumptions made about the surface roughness and orographic effects.

The 24-hour forecasts from the UK global model and the French Emeraude model are compared in Figure 2.11. In the circulation of the storm the highest mean surface-wind speeds shown are 40 kn (Emeraude) or 45 kn (UK) over the sea and 30 kn over land.

The run of the UK fine-mesh model from 1200 GMT 15 October suffered from a timing error, but again produced strong winds in the circulation of the storm, as shown in Figure 2.12. Values over the sea reached 50 kn and there are values of 40 kn over northern France, 35 kn over East Anglia and 30 kn elsewhere in south-east England.

2.7 Assessment of the initial conditions at 0000 GMT 15 October

The 24-hour forecast from the UK global model provided the most accurate guidance of the onset of the storm. It is therefore instructive to examine the initial conditions on which this forecast was based to see which features might hold the key to success.

The sea-level pressure analysis at 0000 GMT 15 October has been discussed in chapter 1. The version calculated for the global model is shown in Figure 2.13 and seems correct in showing an elongated region west of Corunna with pressure below 988 mb. There appear to be three separate low centres within this region, which lies along a pronounced baroclinic zone (note the closely packed isopleths of 850 mb wet-bulb potential temperature in Figure 2.13).

By tracing back the evolution of the 500 mb hjeight field during the forecvast, it may be shown that the important feature for the development of the storm was the trough seen near 30° W in Figure 2.13. Thus, attention is switched to the upper-air flow far out over the Atlantic where the general lack of observations leaves plenty of scope for error in the starting conditions.

Figure 2.14 portrays another feature likely to be important in the dynamics of the storm's development, namely, the jet stream across the North Atlantic at levels mainly between 300 mb and 200 mb. Jet speeds of 170 kn are depicted near 40° W. The definition of this jet in the initial conditions is dependent on reports from aircraft, but the coverage of these is not sufficient to be sure of important details in the horizontal and vertical structure of the jet.

2.8 The forecasters' conclusions regarding the NWP guidance on 15 October

The NWP guidance for this particular event displayed characteristics that forecasters have to contend with most of the time. There are variations in the NWP advice from run to run and between different models. Quite frequently a later run proves to be less accurate than an earlier one. Small errors in track, timing or intensity of weather systems in the NWP guidance can have major consequences for the weather conditions to be expected at particular locations. Often there is the difficulty of determining whether a weather system emphasized by a numerical forecast can be identified with the system that becomes important in the real atmosphere, or whether it is merely a near-neighbour that may evolve differently.

Up to about 0500 GMT on Thursday 15 October the forecasters in CFO could justifiably feel confident of the guidance offered by the morning's fine-mesh numerical forecast. This run was consistent with the guidance from the previous cycle in tracking a low centre across south-east England during the 15th and keeping the very strong winds away from UK land areas. The guidance had been supported by the ECMWF forecast, from 1200 GMT 14 October initial conditions, that had arrived a little before the fine-mesh run.

When the UK global model guidance arrived it offered a markedly different solution with an earlier deepening, a slower movement and a track further to the west, crossing south-west England and the Midlands.

The fine-mesh model has established a reputation among national meteorological services throughout Europe for its ability to handle intense low pressure systems. Case studies have shown that its higher horizontal resolution sometimes permits it to represent dynamical processes that are missed by the global model. On the other hand the fine-mesh model, requiring only a regional coverage of observations, is run with an early data cut-off time. This procedure has important advantages, but it carries the known risk that on rare occasions there will be crucial late observations that miss the fine-mesh cut-off but are used by the global model, which then provides the more accurate forecast as a result.

These factors had to be weighed on the morning of the 15th. The latest observations and satellite imagery were examined for clues as to which solution was the more accurate (see section 2.9 below and Annexes 2.1–2.5). In the event the forecasters elected to compromise between the fine-mesh and the global-model guidance. The subjectively drawn 24-hour prognosis for 0600 GMT 16 October, issued at 0955 GMT 15 October, is reproduced in Figure 2.15 and may be compared with the fine-mesh evolution in Figure 2.9 and the global-model evolution in Figure 2.7. Compared with the fine-mesh guidance, the storm has been deepened, its movement slowed, and its track moved west, all reflecting the influence of the global-model guidance.

The next NWP advice to become available was the afternoon fine-mesh run at around 1500. This turned out to be in remarkably close agreement with the earlier subjective prognosis, as may be seen by comparing Figures 2.10 and 2.15. The afternoon run of the global model, available around 1700, predicted a similar track and rate of movement, though it relaxed the pressure gradients around the storm a little (Figure 2.8).

The story portrayed in Figure 2.15, formulated after the two morning runs and confirmed by the afternoon fine-mesh run, was used as a basis for the issue of forecasts and warnings (see section 2.8 and Annexes 2.1–2.5) until observations finally revealed its errors just a few hours before the onset of the storm over southern England. The errors were as follows:

(a) The expected intensification of the low was only 12 mb as it moved from Biscay (973 mb) across England and out over the North Sea (961 mb). In reality the storm had already deepened to 952 mb as it crossed the English Channel. Consequently the surface wind speeds over south-east England were significantly underforecast.

(b) The predicted track of the low was still too far to the east as it crossed the English Channel. This had the effect of confining the expectation of strong winds over land to a too small part of south-east England.

(c) The expected movement of the low centre along its track was too rapid, with the result that the strong winds were predicted to arrive over south-east England about 4 hours too early.

2.9 Synoptic reviews issued by CFO on 15/16 October

The Senior Forecaster in CFO is responsible for the issue of centralized guidance to all public service forecast offices throughout the country. His responsibilities include advice to the dedicated shipping forecaster, who is also located in CFO, on the issue of gale warnings for all sea areas around the United Kingdom continental shelf. The senior forecaster in turn receives advice from a number of forecasters around him including a colleague of equal rank who is responsible for monitoring and fine-tuning the numerical model analysis before the forecasts are made.

In association with the subjectively drawn 24-hour surface forecast chart referred to above, the senior forecaster issues a descriptive textual guidance routinely 4 times daily, although updates and amendments can be issued at any time. Each issue of the guidance, which is termed a 'synoptic review', is put into 2 or 3 parts (3 parts for the early morning and afternooon issues, i.e. approximately 0400 and approximately 1600 hours). The guidance is designed to add value to selected numerical model products which are received directly by the outstations from Bracknell as well as containing the definitive guidance on the forecast to be followed by all regional offices.

Although outstations are required to follow the central guidance, the procedures involved in formulating the guidance include conferences and discussions with all the regional main meteorological offices at least twice daily and more frequently with the national television and radio presenters.

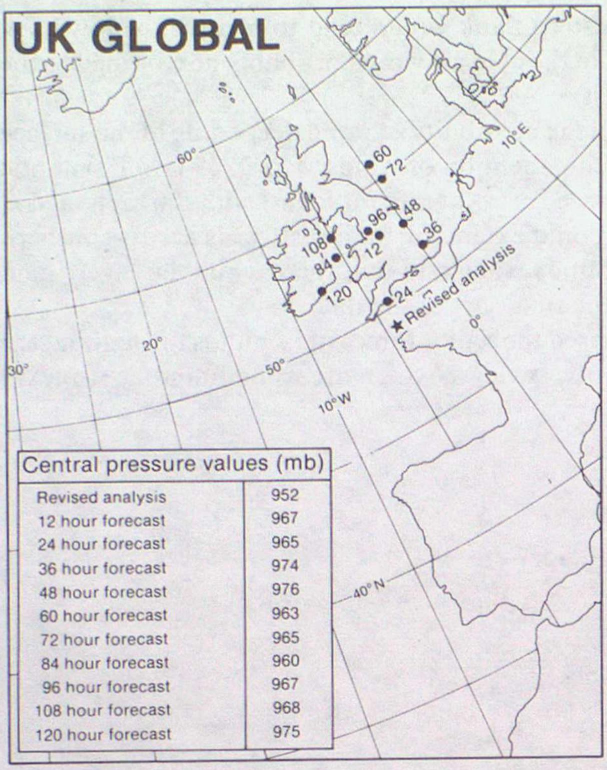
The early morning synoptic reviews were chiefly concerned with the likelihood of heavy rain in the south in view of recent flooding. The Part 1 (issued 0345 GMT 15 October) mentioned the possibility of winds reaching gale force in exposed locations especially in south-east England during the second half of the day. (At this stage, the timing of the evolution was following the latest fine-mesh guidance which proved in the event to be significantly too rapid.) The Part 3 (issued 0550 GMT 15 October) expressed concern about the different model solutions in a rapid developmental situation, concluding that the fine-mesh solution was preferred because of a marginally better initial state. The late morning Part 1 (issued 1010 GMT 15 October) included a land-gale warning for exposed parts of southern and eastern England. The Part 2 (issued 1040 GMT 15 October) suggested a compromise solution between the coarse mesh and the fine mesh for the position and track of the centre. This was because the available observations suggested that the fine-mesh forecast had the better pressure field over France for 0600 GMT on 15th, whilst on the other hand there was a suspicion that it was not developing the low quickly enough.

The senior forecaster was also considering yet another solution throughout the day. Satellite imagery to the south-west of the UK showed a possible 'baroclinic leaf' structure which often precedes rapid cyclogenesis and the formation of an 'instant' occlusion around a development in the cold air. This was yet another compromise solution between the coarse mesh and the fine mesh in which both models would be right to some degree, the first wave running north-east as the fine mesh predicted with the main development following in the cold air. By mid-afternoon the details of the analysis (both surface and upper air) in the critical region were still unclear. The forecaster judged that the main thrust of storm force winds in the moist south-westerly flow was likely to extend over north France but the east Channel and extreme south-east England could be at risk from severe gales. There was also the possibility of severe gales around the development in the cold air, if it occurred.

The fine-mesh solution based on 1200 GMT data showed the expected slight changes of track and speed of the wave, but there was no sign of rapid development or of the formation of an occlusion. The mid-afternoon synoptic review (issued 1535 GMT 15 October) included a land-gale warning stating that the gales would become confined to Scotland tomorrow. This was amended at 1640 GMT in Part 2 to mention severe gale force at times in exposed coastal districts during the evening in the extreme south-east especially in a southerly flow on the eastern flank of the depression. During the late afternoon the wave was approaching the Brest area but pressures were not as low as the fine-mesh forecast. The forecaster considered that rapid cyclogenesis could already be occurring further to the south-west or would shortly occur there; this would steer the low further north for a time but increasing north-westerly flow on the western flank would tend to recurve the low back onto a more easterly track and the strongest winds in the cold air would probably be confined to the English Channel coasts and the extreme south-east.

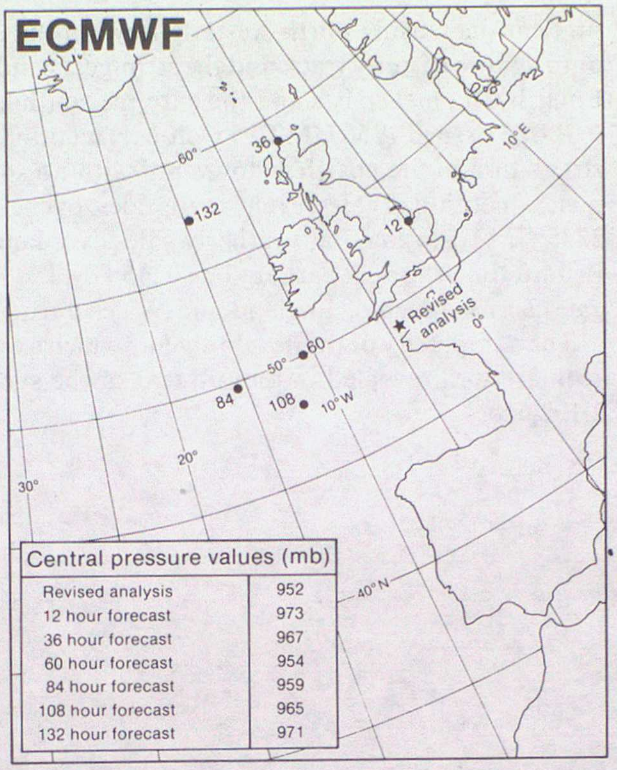
Part 3 (issued 1750 GMT 15 October) mentioned the possibility of rapid deepening of the surface circulation in the next few hours but with no specific mention of winds. The 2225 GMT synoptic review mentioned gales, even severe gales, over exposed areas of the south-east with Part 2, issued at 2235 GMT, stating that southerly gales over land could extend further westwards across southern Britain than thought earlier. The 0345 GMT synoptic review said that there would be severe land gales across much of England and Wales during the first part of the day.

The complexity of the developments which exercised the senior forecasters' minds throughout the 15th are well revealed in the full text of the synoptic reviews, which are to be found at Annexes 2.1–2.5.


UK GLOBAL
60°
20°
30°
50°
10°W
0°
10°E
40°N
60
72
96
48
36
108
12
84
120
24
Revised analysis

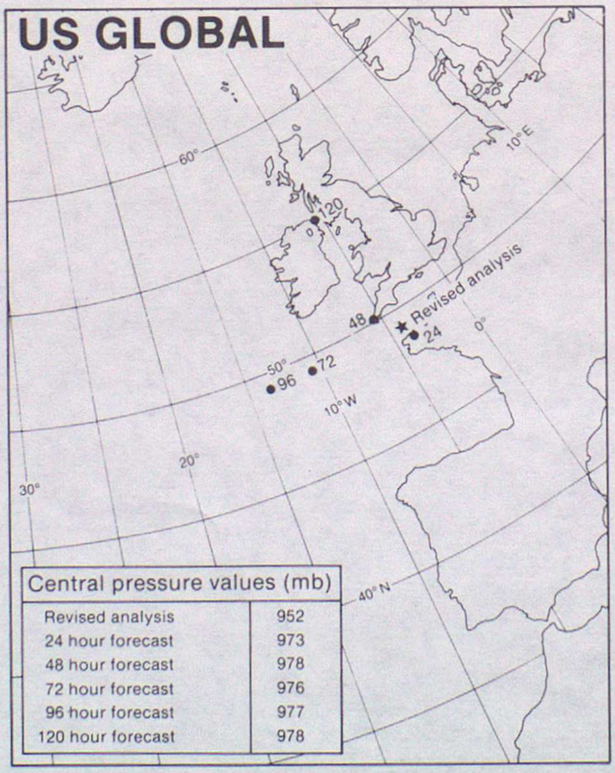
Central pressure values (mb)	
Revised analysis	952
12 hour forecast	967
24 hour forecast	965
36 hour forecast	974
48 hour forecast	976
60 hour forecast	963
72 hour forecast	965
84 hour forecast	960
96 hour forecast	967
108 hour forecast	968
120 hour forecast	975

Figure 2.1 Location and pressures of the storm at 0000 GMT 16 October 1987 forecast by the UK global NWP model and analysed using all available data (revised analysis).


ECMWF
60°
36
132
12
10°E
Revised analysis
0°
50°
60
84
108
10°W
20°
30°
40°N

Central pressure values (mb)	
Revised analysis	952
12 hour forecast	973
36 hour forecast	967
60 hour forecast	954
84 hour forecast	959
108 hour forecast	965
132 hour forecast	971

Figure 2.2 As Figure 2.1 but from the ECMWF NWP model.


US GLOBAL
60°
10°E
120
Revised analysis
48
24
0°
50°
72
96
10°W
20°
30°
40°N

Central pressure values (mb)	
Revised analysis	952
24 hour forecast	973
48 hour forecast	978
72 hour forecast	976
96 hour forecast	977
120 hour forecast	978

Figure 2.3 As Figure 2.1 but from the US global NWP model.

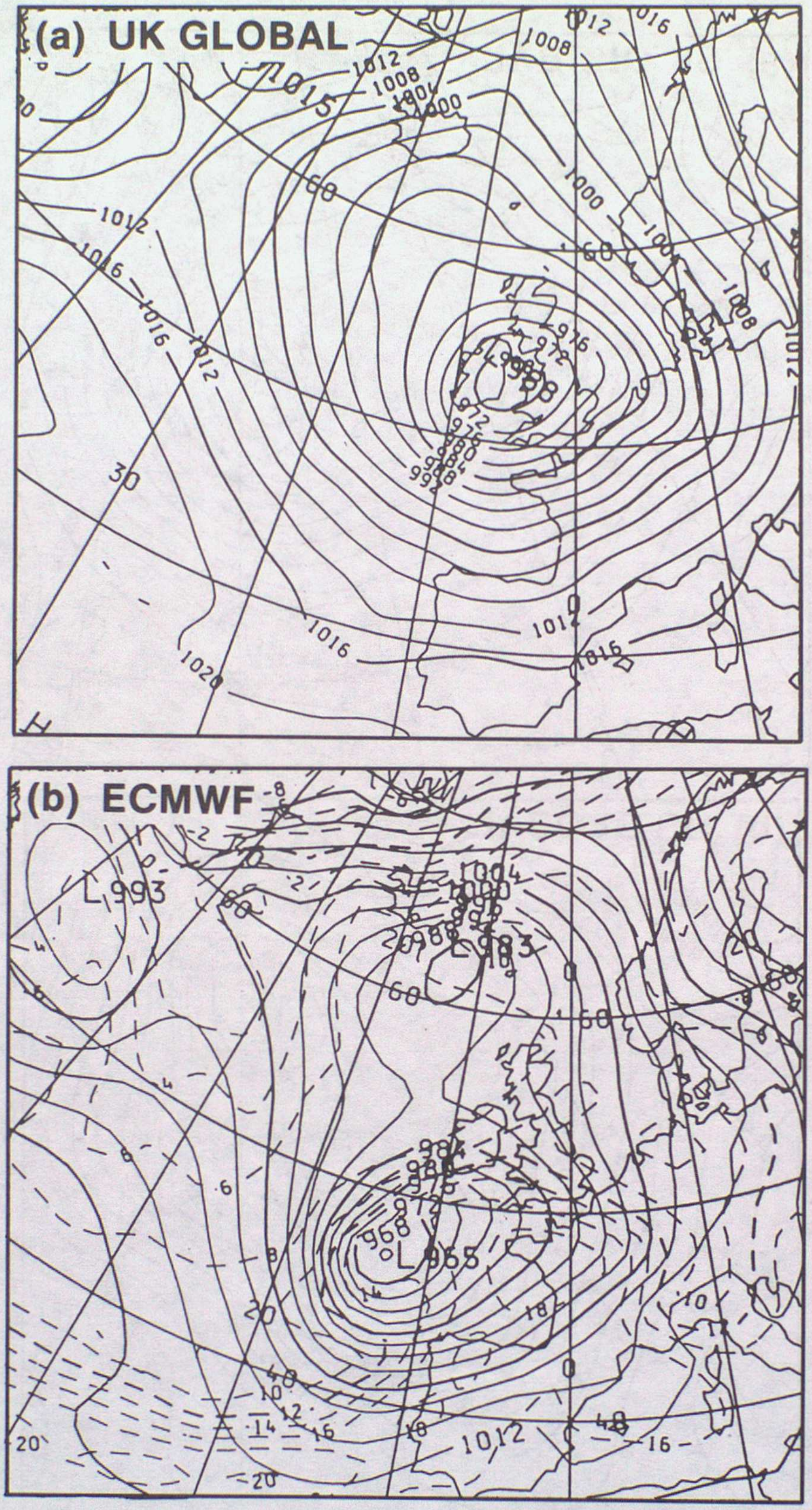

(a) UK GLOBAL
1012
1008
1004
1000
1016
1015
60
976
972
968
30
1020
1012
1016
H
(b) ECMWF
L993
L983
988
60
L965
968
984
980
976
972
20
40
1012
48
16
20

Figure 2.4 108-hour numerical forecasts valid at 0000 GMT 16 October 1987 from (a) the UK global model and (b) the ECMWF model.

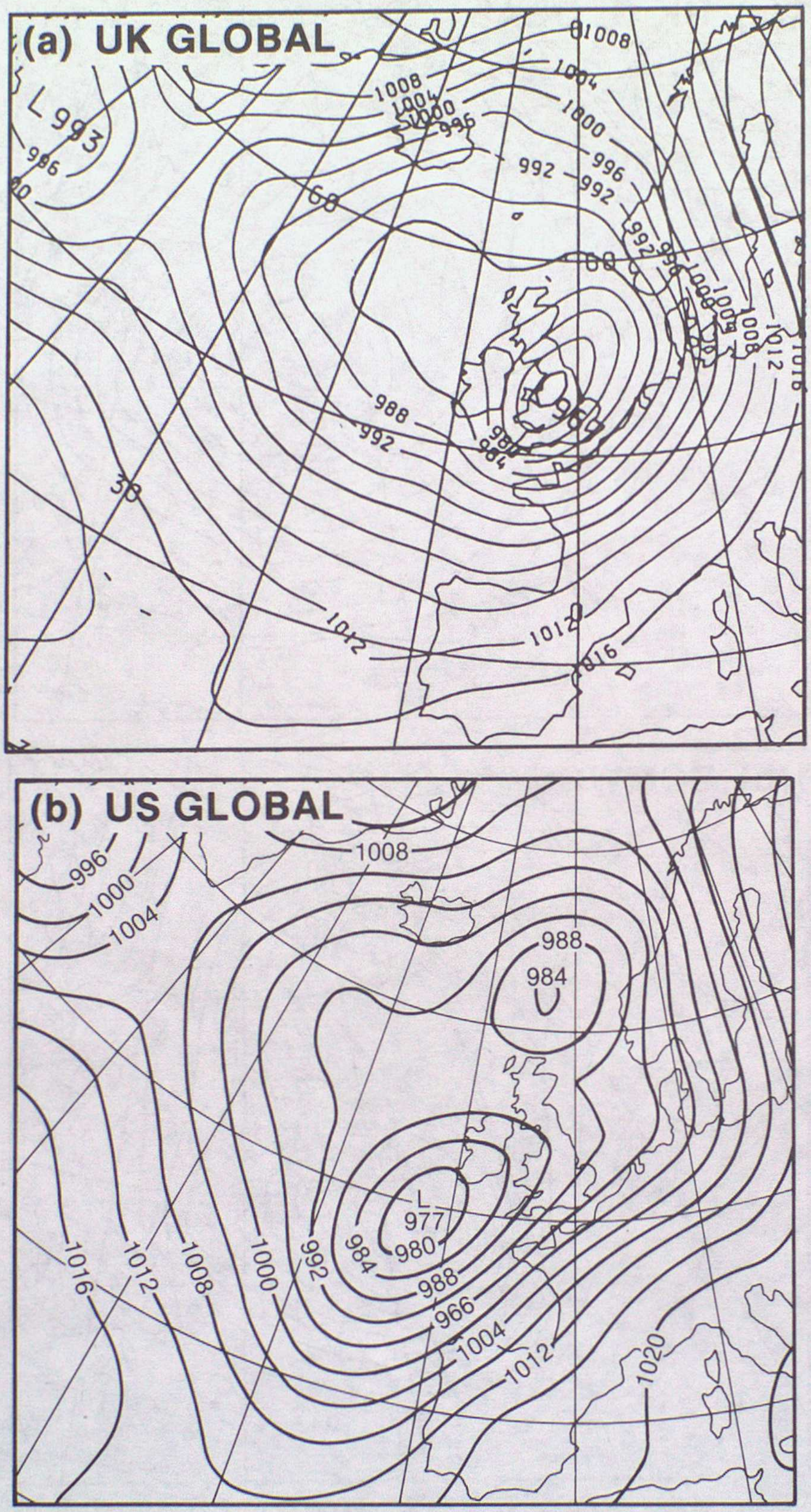

(a) UK GLOBAL
L 993
996
1008
1004
1000
996
992
988
984
980
969
1012
1016
60
30
(b) US GLOBAL
996
1000
1004
1008
988
984
L
977
980
984
988
992
1000
1004
1008
1012
1016
1020
966

Figure 2.5 96-hour numerical forecasts valid at 0000 GMT 16 October 1987 from (a) the UK global model and (b) the US global model.

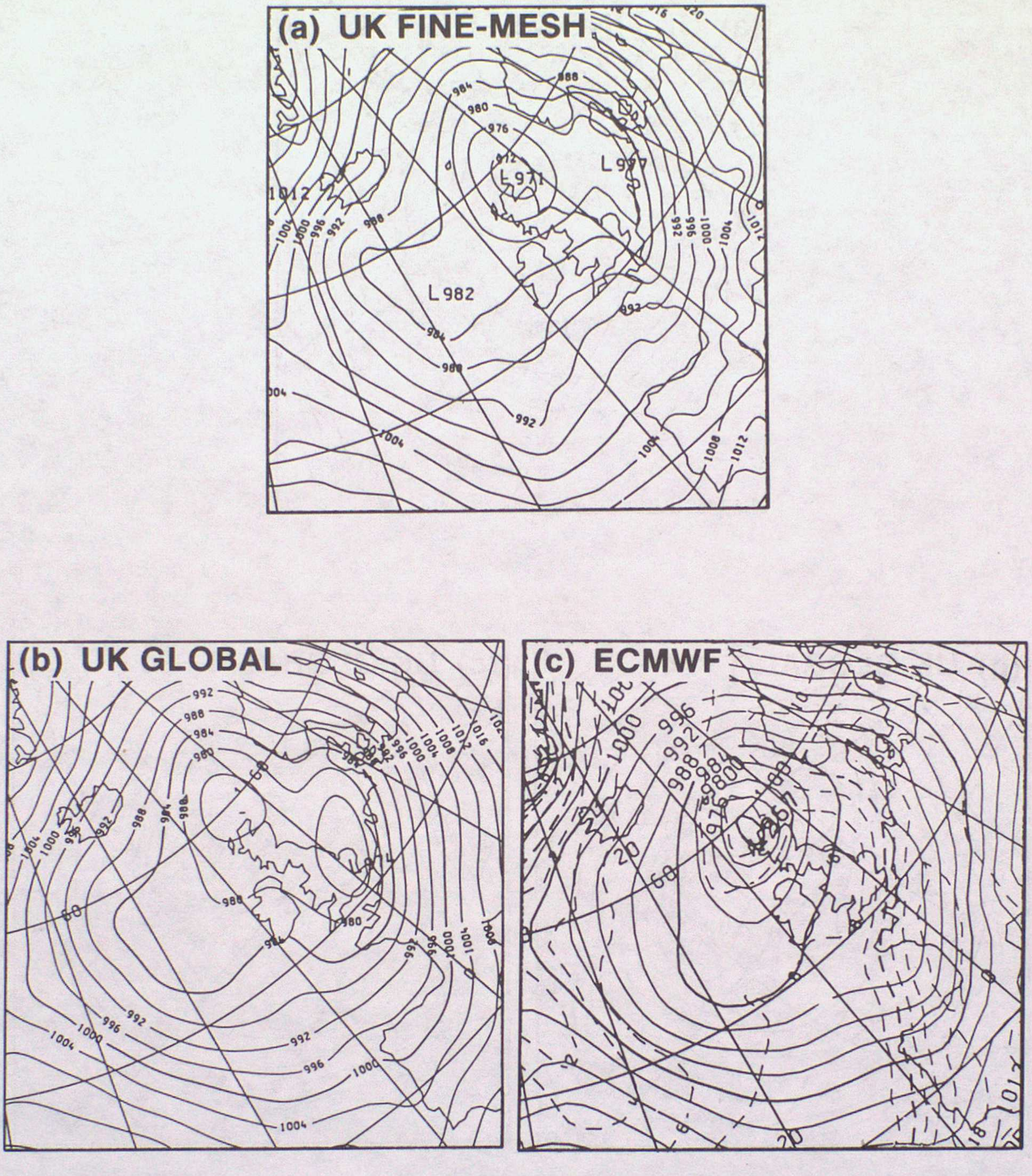

(a) UK FINE-MESH
L971
L977
L982
1012
(b) UK GLOBAL
980
(c) ECMWF

Figure 2.6 36-hour numerical forecasts valid at 0000 GMT 16 October 1987 from (a) the UK fine-mesh model (b) the UK global model and (c) the ECMWF model.

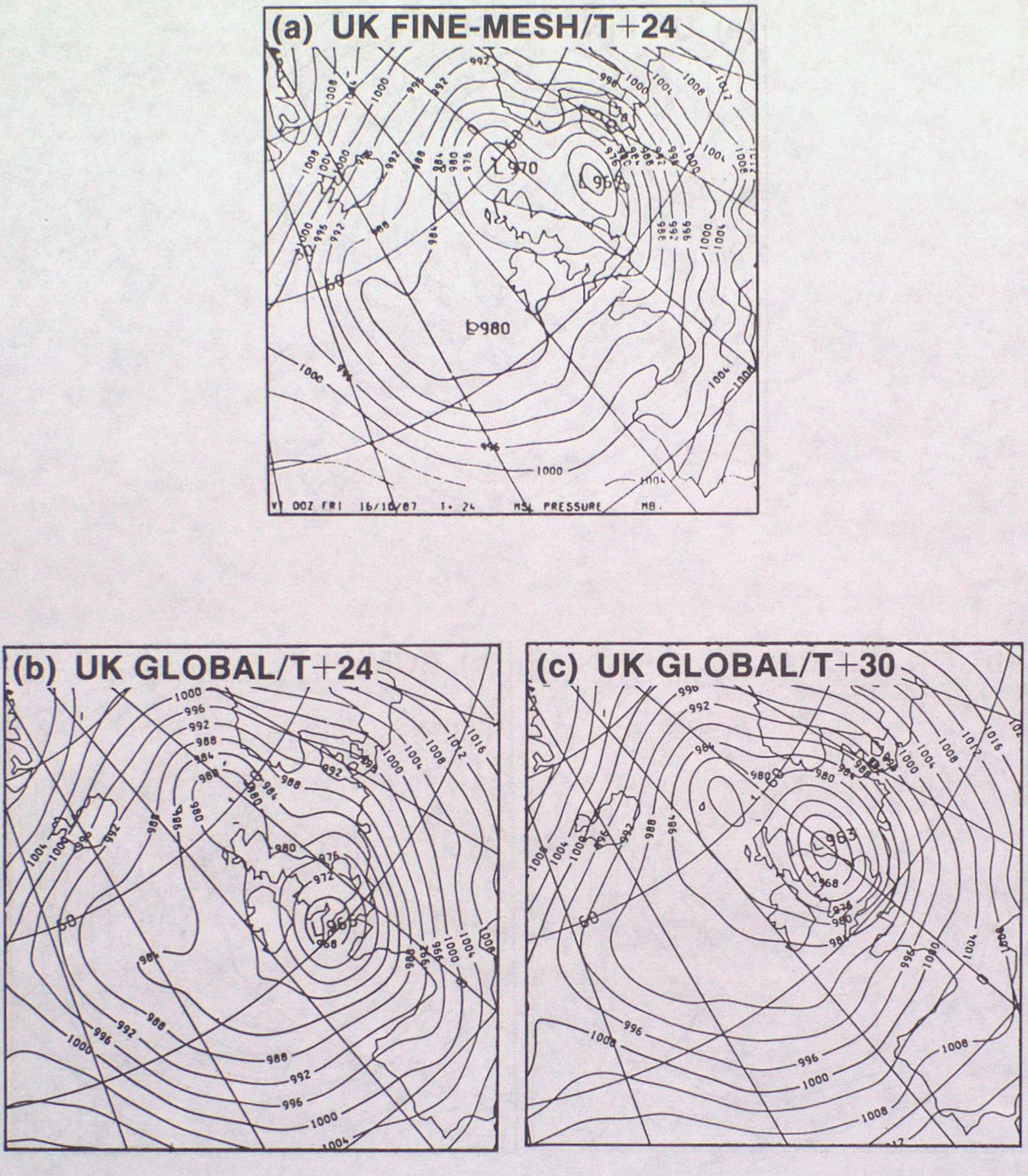

(a) UK FINE-MESH/T+24
L 970
L 980
VT 00Z FRI 16/10/87 T+24 MSL PRESSURE MB.
(b) UK GLOBAL/T+24
(c) UK GLOBAL/T+30
963

Figure 2.7 24-hour numerical forecasts valid at 0000 GMT 16 October 1987 from (a) the UK fine-mesh model and (b) the UK global model, and (c) 30-hour numerical forecast valid at 0600 GMT 16 October 1987 from the UK global model.

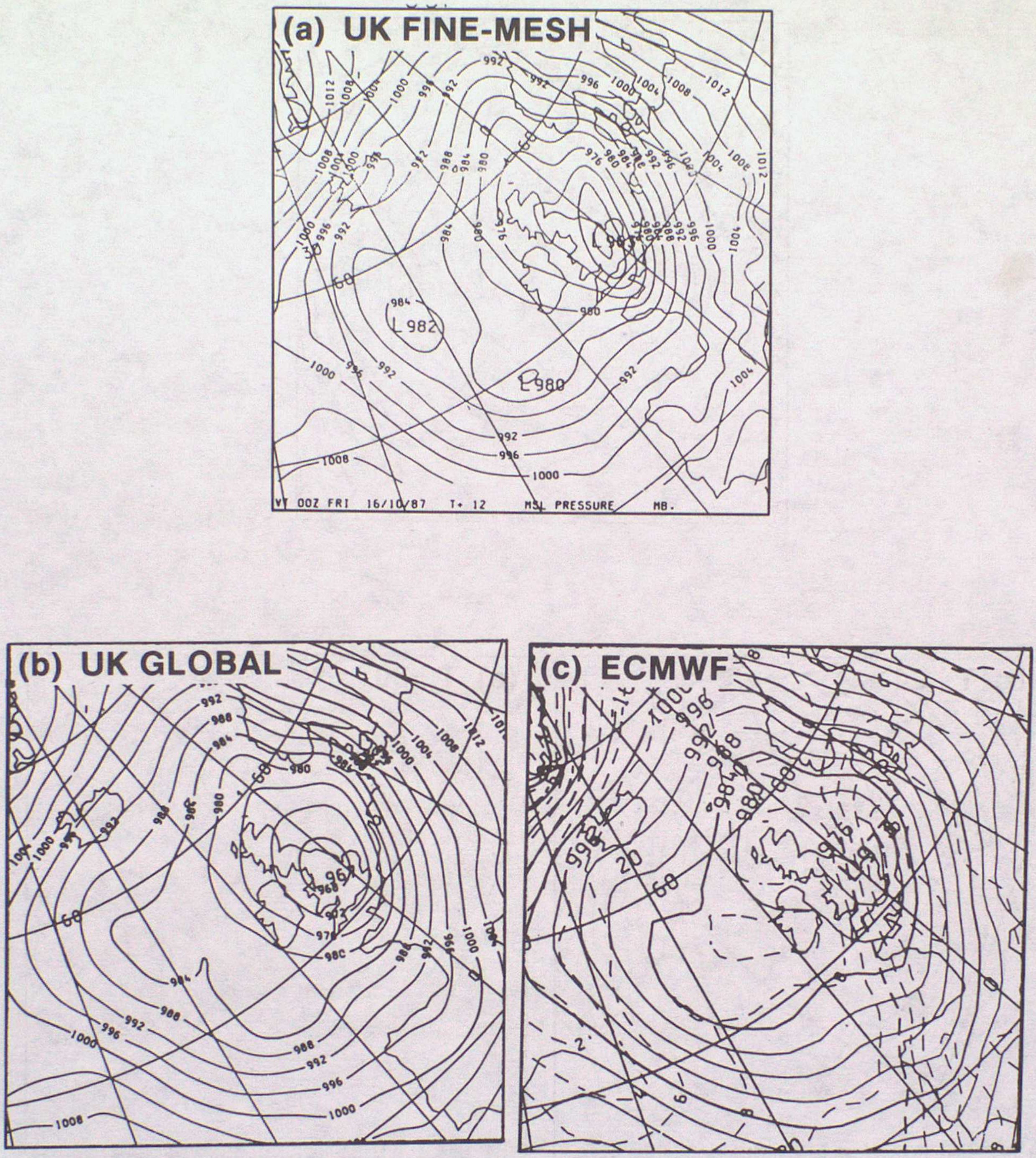

(a) UK FINE-MESH
L 982
L 980
VT 00Z FRI 16/10/87 T+ 12 MSL PRESSURE MB.
(b) UK GLOBAL
(c) ECMWF

Figure 2.8 12-hour numerical forecasts valid at 0000 GMT 16 October 1987 from (a) the UK fine-mesh model (b) the UK global model and (c) the ECMWF model.

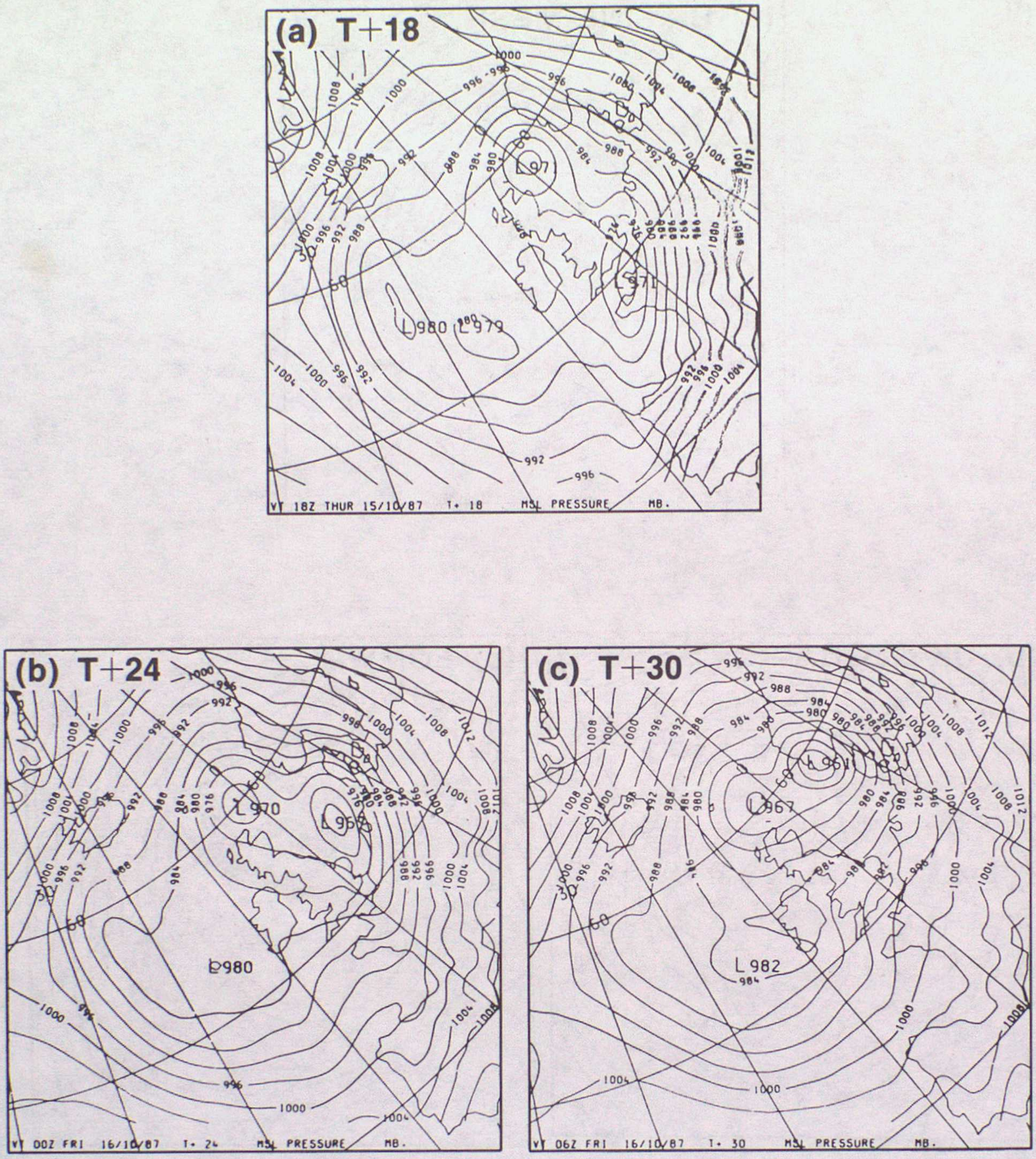

(a) T+18
VT 18Z THUR 15/10/87 T+ 18 MSL PRESSURE MB.
(b) T+24
VT 00Z FRI 16/10/87 T+ 24 MSL PRESSURE MB.
(c) T+30
VT 06Z FRI 16/10/87 T+ 30 MSL PRESSURE MB.

Figure 2.9 Sequence of numerical forecasts from the UK fine-mesh model based on 0000 GMT 15 October 1987.

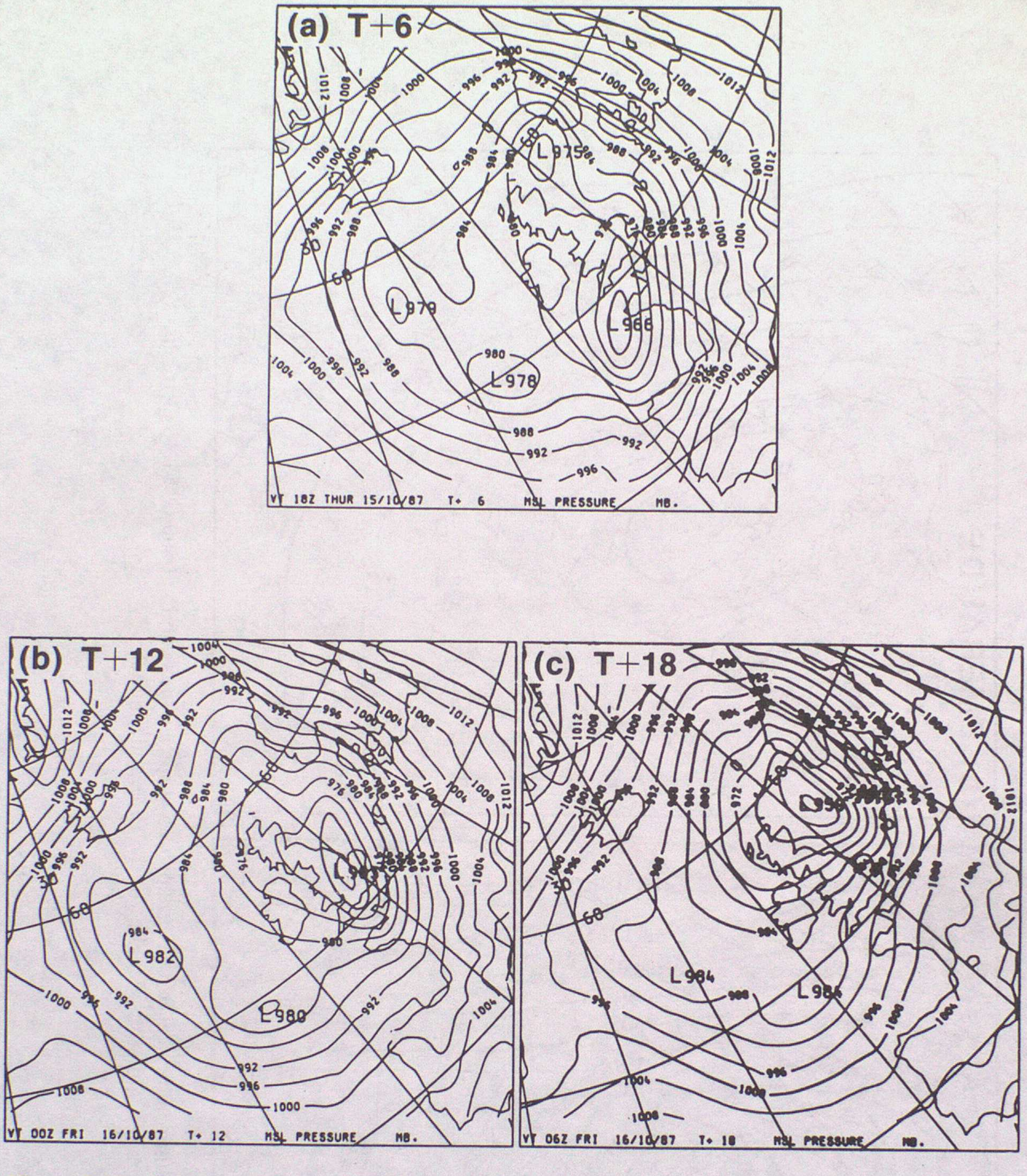

(a) T+6
L975
L979
L966
L978
VT 18Z THUR 15/10/87 T+ 6 MSL PRESSURE MB.
(b) T+12
L982
L980
VT 00Z FRI 16/10/87 T+ 12 MSL PRESSURE MB.
(c) T+18
L984
L984
VT 06Z FRI 16/10/87 T+ 18 MSL PRESSURE MB.

Figure 2.10 Sequence of numerical forecasts from the UK fine-mesh model based on 1200 GMT 15 October 1987.

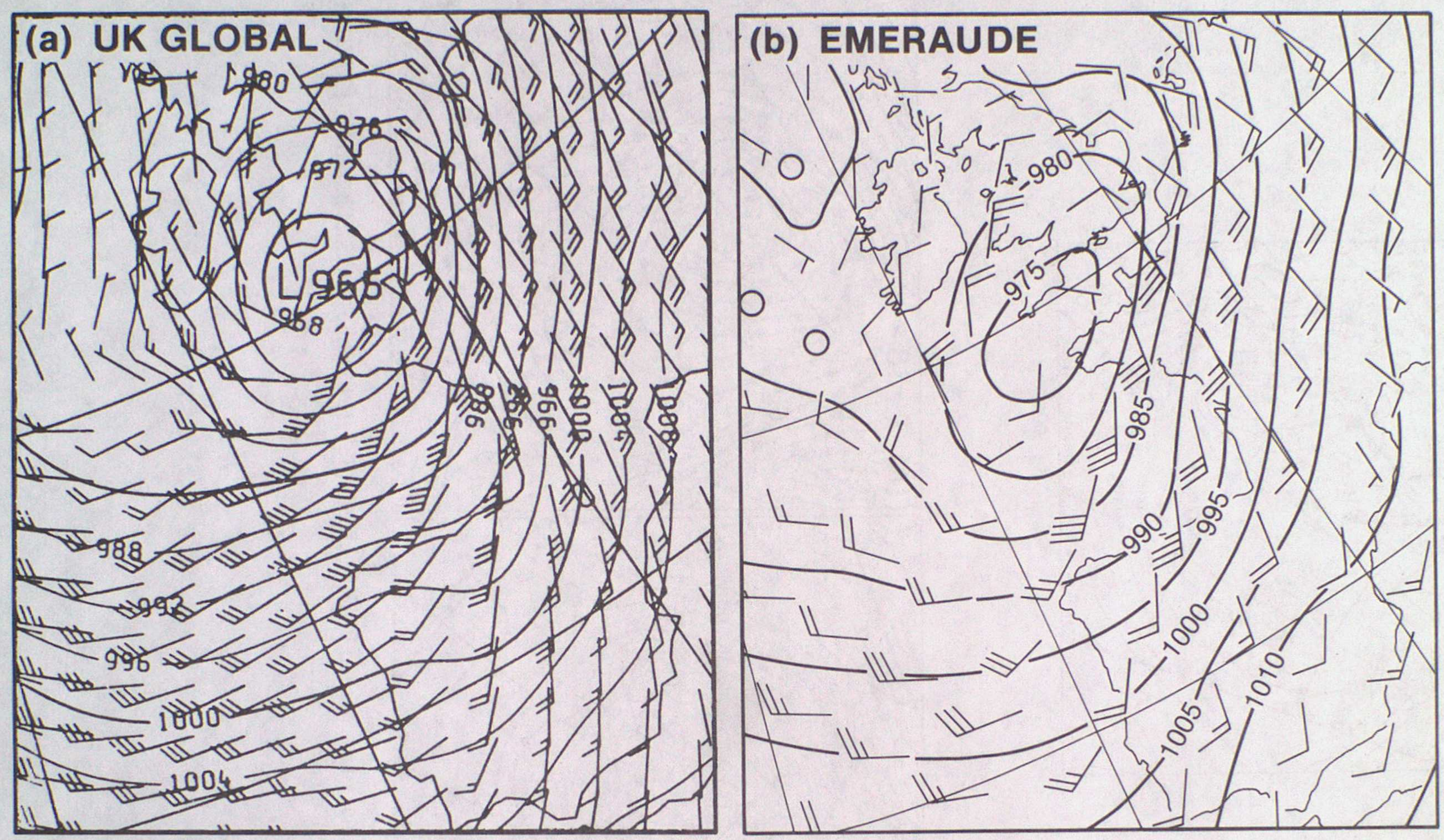

(a) UK GLOBAL
980
976
972
L 965
968
988
992
996
1000
1004
1008
(b) EMERAUDE
980
975
985
990
995
1000
1005
1010

Figure 2.11 24-hour numerical forecasts depicting surface winds valid at 0000 GMT 16 October 1987 from (a) the UK global model and (b) the Emeraude model.

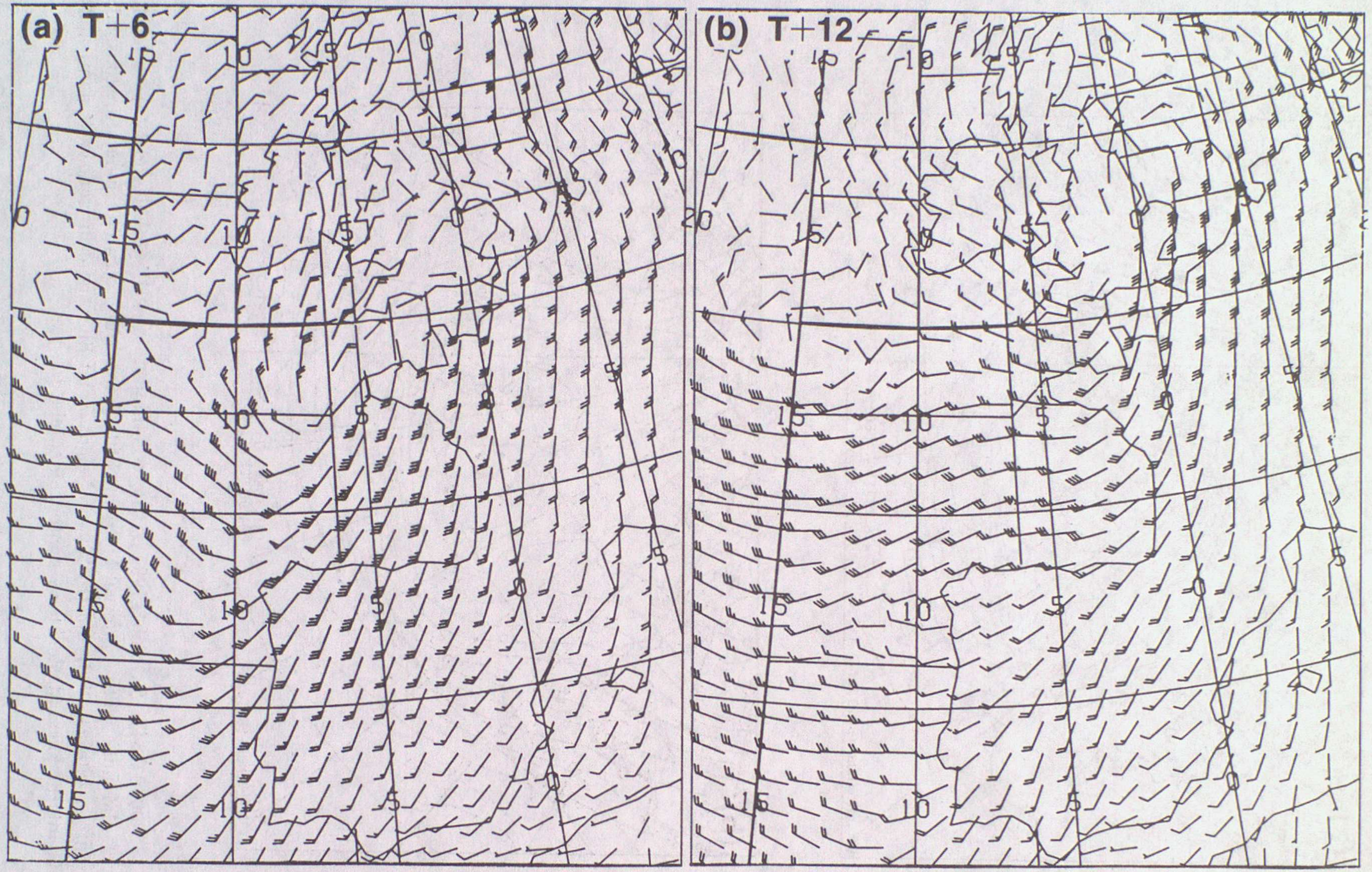


Figure 2.12 Numerical forecast from the UK fine-mesh model depicting surface winds based on 1200 GMT 15 October 1987; (a) 6-hour forecast valid at 1800 GMT 15 October and (b) 12-hour forecast valid at 0000 GMT 15 October 1987.

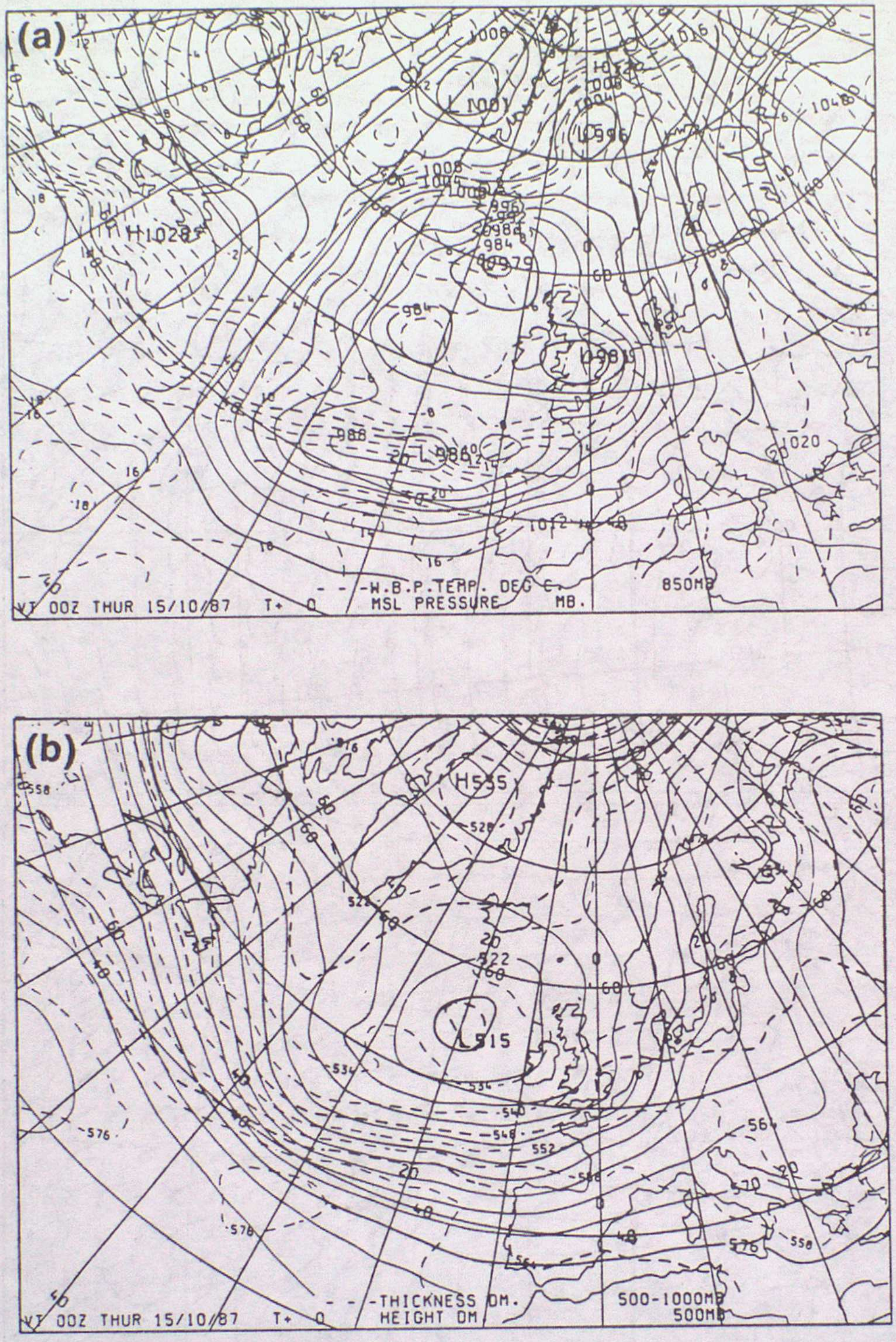

(a)
H1028
L1001
L996
L979
L981
L986
988
984
1008
1016
1020
1048
VT 00Z THUR 15/10/87 T+ 0
W.B.P.TEMP. DEG C.
MSL PRESSURE MB.
850MB
(b)
H555
L515
522
528
534
540
546
552
558
564
570
576
VT 00Z THUR 15/10/87 T+ 0
THICKNESS DM.
HEIGHT DM.
500-1000MB
500MB

Figure 2.13 0000 GMT 15 October 1987 starting conditions for the UK global model: (a) sea-level pressure (solid lines, contour interval 4 mb) and 850 mb wet-bulb potential temperature (dashed lines, contour interval 2°C) and (b) 500 mb height (solid lines, contour interval 6 dam) and 1000–500 mb thickness (dashed lines, contour interval 6 dam).

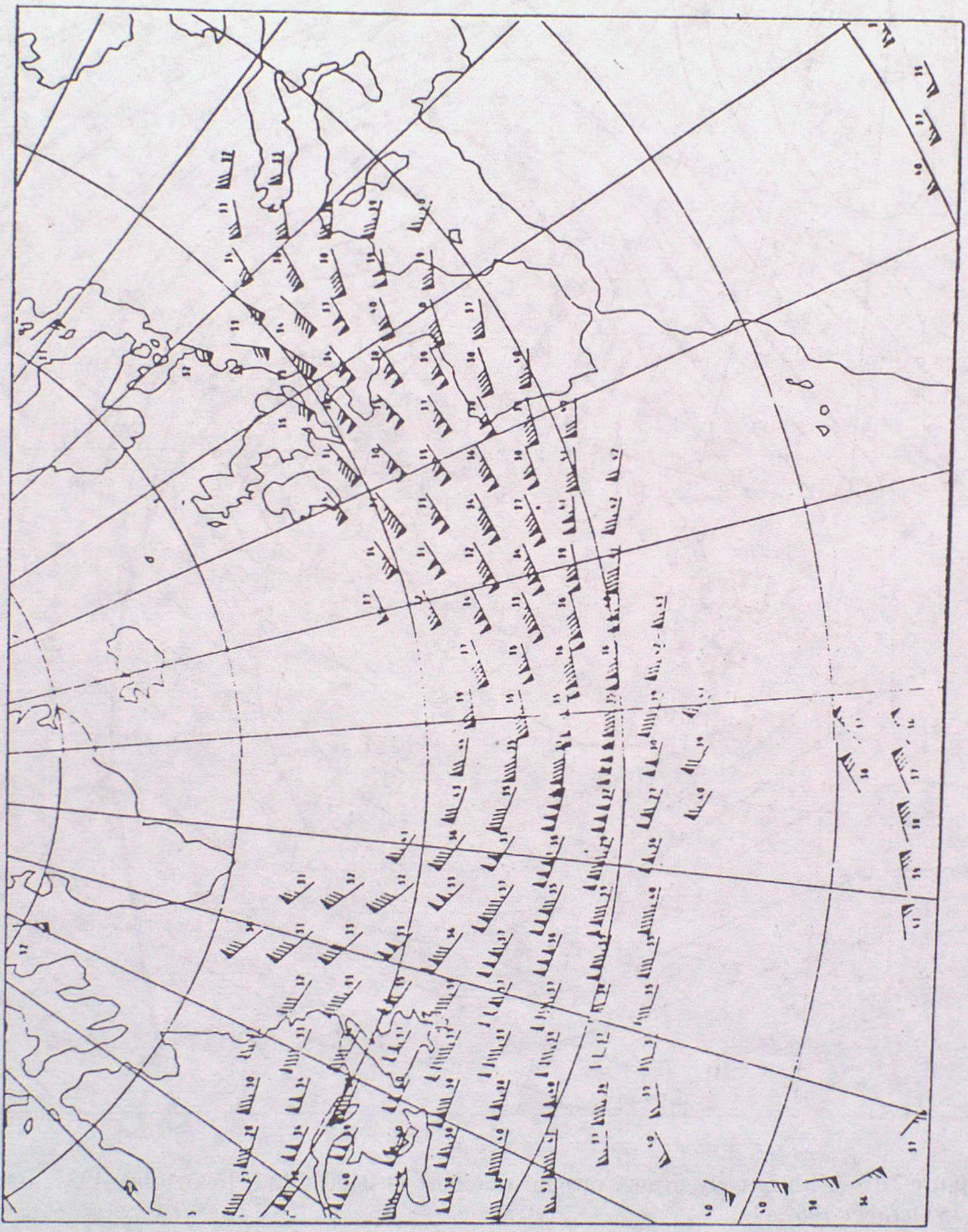


Figure 2.14 0000 GMT 15 October 1987 starting conditions for the UK global model: maximum wind and its height (in thousands of ft).

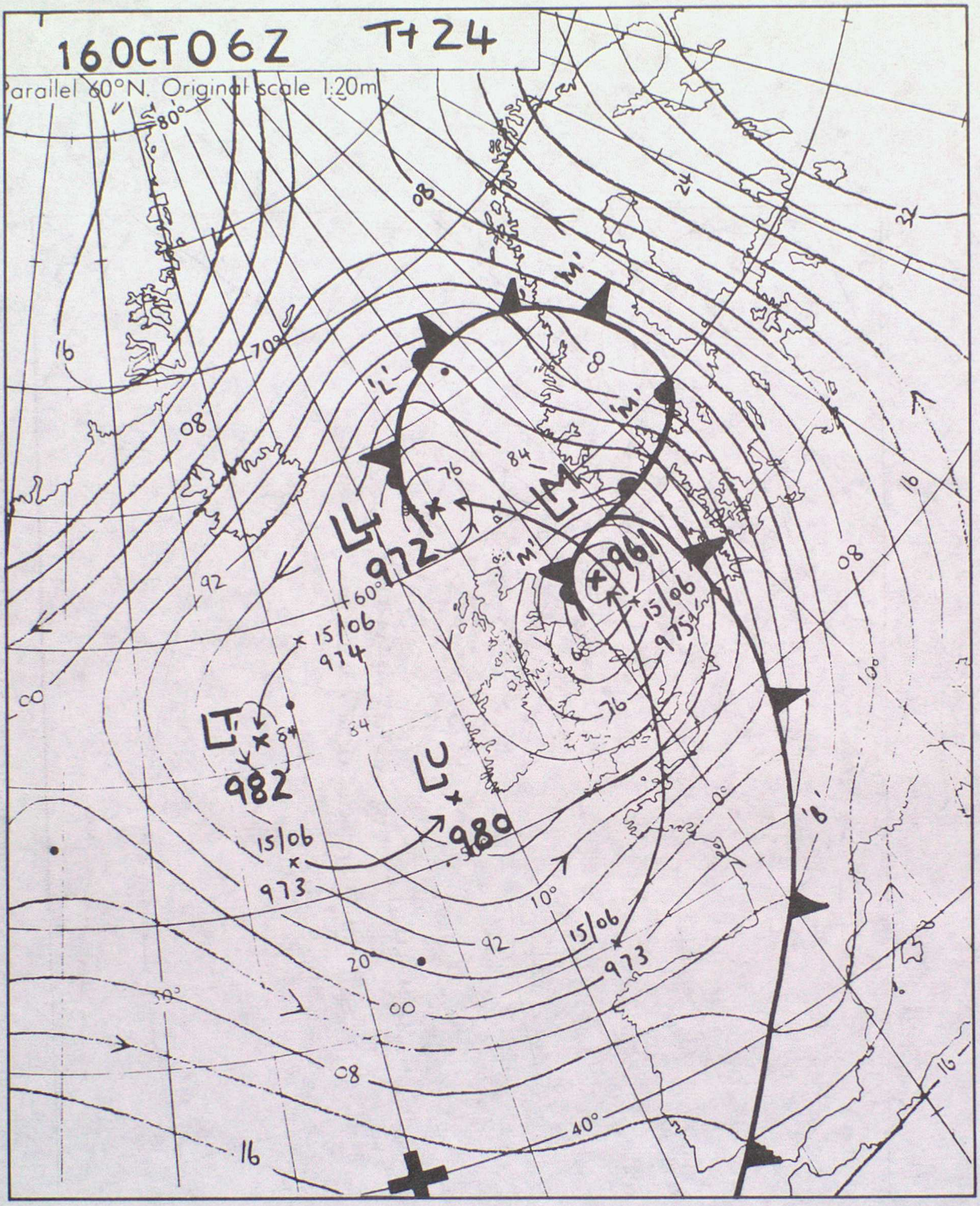

16OCT06Z T+24
Parallel 60°N. Original scale 1:20m
80°
70°
60°
50°
40°
30°
20°
10°
0°
10°
'M'
'L'
'M'
LM
L 972
L 961
LT 982
LU 980
15/06 974
15/06 975
15/06 973
15/06 973
'B'
08
16
24
32
84
76
92
00
08
16
68

Figure 2.15 Subjectively drawn prognostic chart at 0600 GMT 16 October 1987, issued 0955 15 October 1987.

List of Annexes

Annex 2.1 Main synoptic review number 43 (Part 1 issued at 0345 GMT 15 October 1987).

Annex 2.2 Main synoptic review number 44 (Part 1 issued at 1010 GMT 15 October 1987).

Annex 2.3 Main synoptic review number 46 (Part 1 issued at 1545 GMT 15 October 1987).

Annex 2.4 Main synoptic review number 47 (Part 1 issued at 2225 GMT 15 October 1987).

Annex 2.5 Main synoptic review number 48 (Part 1 issued at 0345 GMT 16 October 1987).

Annex 2.1 Main synoptic review number 43 (Part 1 issued at 0345 GMT 15 October 1987).

Warnings

Thunder, fog, frost.

Nowcast

Area of moderate rain northern England moving north, FRONTIERS unable to give speed due to malfunction.

Fine mesh

Reasonably good analysis although rather more weight given to the low centre near 43 N 19 W than to that near 44 N 10 W ie the opposite of the CFO analysis. South Wales low disappears rather too suddenly despite being well analysed at 0000 GMT. The limit to rain over southern England later today in line with earlier ideas.

Forecast

Low over Essex at 0000 GMT will track northwards to be located near 60 N 00 L by midnight tonight. Low over south Wales will track north northeastwards and be absorbed in the circulation of the Essex low. Area of rain at present over northern England will continue northwards to be over central Scotland by mid-day today and the northwest Highlands by midnight, with some hill fog and some moderate and heavy spells of rain possibly accompanied by thunder. Apart from a few mist of fog patches in inland spots, most areas north the rain will start bright (with air frost in some upper valleys) but upper cloud will soon increase from the south. After rain at first, Northern Ireland and northern England will have broken cloud for much of the day, perhaps with coastal showers. Much of south Wales and southern England will start dry with a few coastal showers mainly in the west. Upper cloud will soon arrive over the southwest however and spread to much of southern England and south Wales and the Midlands during the morning. In the afternoon outbreaks of moderate rain with some heavy bursts, possibly with thunder will spread from the south coast to affect much of England south of a line from Bristol to Lincolnshire by dusk. The rain will clear from the west to leave much of England west of the meridian dry by midnight, but coastal showers could continue over night and near west facing coasts. Winds could reach gale force in exposed locations especially over southeast England during the second half of the day. Temperatures near normal in the brighter areas but rather cold where rain persists.

MAIN SR NO. 43 PART (2) ISSUED 15/0440

The main fine mesh run handles the next pulse of warm air from the south in a very similar fashion to the previous coarse mesh run and so the timing and northern limit of the rain over southern England described in Part 1 have followed the fine mesh quite closely. The one weakness of the fine mesh seems to be the abrupt filling of the Welsh low before 0600 GMT.

The mesoscale model maintains a vortex between the Isle of Man and Liverpool at 0600 GMT and fills it by about 0900 GMT which seems rather more realistic than the fine mesh. The track of low A keeps the air with highest WBPT (18C) over France but there could still be some significant falls of rain in the extreme southeast corner of England during the second part of the day. MOS temperatures look rather high over southern England for today given likely cloud cover and rain. Tonight's values seem generally realistic with ground frost possible in eastern Scotland and in east Wales. Most of the T+36 forecast ascents are very unstable suggesting rather more widespread showers than the T+36 frame indicates with some CB activity.

MAIN SR PART (3) ISSUED 15/0550

Coarse mesh material is now to hand and gives a track of low A at T+24 which is about 5° further west than the fine mesh. This may be due to a rather crude treatment of the low centres west of Corunna on the 00 GMT coarse mesh analysis; basically the two low centres on the ASXX have been merged into one elongated low and displaced a few degrees to the west. In a situation of rapid development on the forward side of the upper trough the initial analysis must be crucial to the short term evolution and in this instance the fine mesh solution is preferred because of its marginally better initial state. In the longer term the coarse mesh solution is similar in many respects to yesterday's 12 GMT ECMWF solution.

Annex 2.2 Main synoptic review number 44 (Part 1 issued at 1010 GMT 15 October 1987).

Warnings

Thunder, land gale, frost and fog.

Nowcast

Rain echoes in Channel now moving onto south coast at about 210° 25-30 kt.

Forecast

Rain in northern districts in the circulation of low L will gradually retreat northwards becoming chiefly confined to northern Scotland by evening with some cloud breaks elsewhere in the north and scattered showers in coastal areas. Over night the rain in northern Scotland should gradually turn more showery. Clear periods and light winds in sheltered parts of the north could give radiation fog patches and a touch of frost. In southern Britain rain ahead of the wave complex moving northeast over west France will gradually spread north this afternoon becoming heavy by evening in southern counties. The northern edge of the rain is likely to be from about Cardiff to Lincoln this afternoon, but this evening rain is expected to extend further north over central and northeast parts of England as a deepening complex moves east over southern and eastern England into the North Sea. Clearer weather with coastal showers is expected to follow from the west overnight but may not reach parts of eastern England until tomorrow morning. Otherwise tomorrow will be a generally dry day of broken CU and CB with showers. The showers will start mainly in the exposed coastal parts spreading to inland areas during the day some heavy with perhaps hail and sleet the latter chiefly on northern hills and minor troughs could lead to more prolonged showers at times. There will be a high risk of thunder in the heavy showers tomorrow and a moderate risk in the heavy rain in the south this evening and tonight. Temperatures generally rather below normal but colder in rain areas today. Windy at times with possibly gales in the far north near low L and in exposed parts of the southern and eastern England and the circulation of the low complex LA/LM this evening and tonight.

Fine mesh

Evolution preferred to coarse mesh but situation probably more complex. Fine mesh considered too fast with clearance of low on precipitation from eastern England over night.

MAIN SR NO. 44 (PART 2)

The situation is highly cyclogenetic to the southwest of Britain with the mobile upper trough moving quickly east to the south of 45°N rounding the base of the long wave trough to the west of Spain and engaging the waves on cold CB. The surface analysis is complex in the region of the waves and the difference between the fine mesh and coarse mesh solutions shows how critical minor analysis differences can be on the track and evolution of the developing low. Pressure changes over France suggests the fine mesh has got a better solution for the first wave (now in Biscay) but pressures are still lower than predicted and it is probably not handling the details of the evolution too well. The ECMWF solution based on yesterday's 12 GMT data is much like the fine mesh keeping the wave rather flat as it crosses the southeast tonight with the main 'spin-up' of the low in the North Sea. Events suggest a solution between the fine mesh and coarse mesh should be most likely with the 'spin-up' occurring earlier than the fine mesh but further east than the coarse mesh as it moves into the Channel and south east England later today. There could be more than one low developing with a possible new development in the cold air. As it deepens the low complex is expected to slow down over northern England tonight with a slower clearance of the rain.

Annex 2.3 Main synoptic review number 46 (Part 1 issued at 1545 GMT 15 October 1987).

Warnings

Thunder, land gale, frost and fog.

Nowcast

Northward component of precipitation edge over England and Wales is about 15 kn. Individual elements moving rapidly east northeast in the upper flow.

Fine mesh

Analysis seemed reasonable. Slow evolution and movement of rain further north.

Forecast

Rain shield associated with waves spreading north over south and east Wales the Midlands and northern England this evening. The rain heavy especially in the southeast with hill fog patches. Somewhat drier and clearer weather following into the western, central and southern areas but clearance not reaching northeast England perhaps East Anglia until the morning. Coastal showers in the clearer air. To the north of the rain shield outbreaks of rain over Scotland, Northern Ireland and Northern England associated with the low L system slowly dying out from the south spreading westwards over northern Scotland. Though there will be generally a lot of cloud in the north with very light winds in the cold area between the two systems there is a minimum risk of fog patches and perhaps ground frost where skies do clear for a time. Later in the night the southern rain shield is likely to reach parts of southern and eastern Scotland. Tomorrow after the clearance of the rain shield in some eastern parts of England and Scotland it will be a generally windy and showery day, the showers most frequent in exposed on-shore coastal areas especially in northern and western Scotland but there may be some long outbreaks of rain. Some of the showers will be heavy with hail and perhaps sleet in the north. Sheltered parts of eastern England to the lee of high ground should become mostly dry with only isolated showers. Sunny intervals should develop during the day but a cold air trough is expected to enhance the showers and cloud in Wales and south west England during the afternoon. The heavier showers tomorrow and the heavier rain the rain shield tonight may be accompanied by thunder. Temperatures generally rather below normal. Gales in exposed parts near the circulation of the developing low becoming confined to Scotland tomorrow.

MAIN SR NO. 46 (PART 2) ISSUED 15/1640

Current continuity on the rain edge in the south is much in line with the fine mesh T+06 frame. The fine mesh subsequent timing seemed realistic though there may be overhang of cloud and rain down North Sea coastal districts on the T+18 frame. The mesoscale timings also seem reasonable with some rain reaching southern Scotland by 03 GMT and spreading up the east coast later. The expect track of the low is from Brest through southern England and into the North Sea near the Humber but the wave is likely to be rather complex and the new low could well develop in the cold air become the dominant low as a occlusion starts. MOS minima tonight in the southeast are representative of the model air temperatures expected at midnight. MOS figures do not take account of air mass changes and so are unrealistic of this occasion. MOS maxima tomorrow seem reasonable although they could be a shade high in the southeast.

Amends to Part 1

Winds in the circulation of the deepening wave could reach severe gale force at times in exposed coastal districts this evening especially in the southerly flow on the eastern flank of the low and over the extreme southeast.

MAIN SR NO. 46 (PART 3) ISSUED 15/1750

The short term solution of 12 GMT coarse mesh run is very similar to the fine mesh, the T+24 and T+36 positions of the low tracking north near the Shetlands practically identical. In the longer term it is somewhat slower than its previous run with the next system on Saturday and agrees very well with the previous ECMWF solution. Meanwhile this evening the observations in the southwest and the Brest peninsula seem to confirm the fine mesh 18 GMT position of the wave though the fine mesh pressures seem too low. Satellite imagery on the other hand shows a drier slot starting to become involved with the wave and this often precedes rapid deepening. Consequently there could well be an accelerated deepening of the surface circulation in the next few hours possibly with a complex development.

Annex 2.4 Main synoptic review number 47 (Part 1 issued at 2225 GMT 15 October 1987).

Warnings

Land gales, thunder.

Nowcast

New low forming on warm front WM moving north over East Anglia. Ample feed of moist air from southwest over Wales and England. Northern edge of rain over north Wales moving from about 210 at 30 kt, but individual rain elements within precipitation area moving at a wide range of speeds.

Fine mesh

Pressures now falling over southwest England at a greater rate than the fine mesh predicts so track of low M likely to be somewhat to the northwest of the fine mesh track. Northern edge of rain adjusted accordingly.

Forecast

Extensive area of rain associated with low M will spread northeastwards over night to affect all of Wales, England and parts of southern and eastern Scotland. The rain will be heavy at times with a risk of thunder, with hill fog. Heavy rain could occur almost anywhere but Wales and northern England would seem unlikely to escape some significant falls. Gales or even severe gales are likely over exposed areas of the south east during the night. Dry conditions will extend from the west later in the night and Wales and much of England except the extreme northeast will become dry by dawn, except perhaps for a few coastal showers in the west. Southern and eastern districts of Scotland will be mainly dry first as the rain in the circulation of low L moves slowly northwestwards, but the rain area advancing from the south will bring further rain to southern and eastern Scotland by dawn. Western and northern Scotland will remain wet over night with some moderate bursts of rain. Northern Ireland will remain mostly dry over night except perhaps for a few showers or light rain near the north coast. Tomorrow although the the northeast of England will start cloudy with some rain much of England and Wales will have a showery day with broken cloud, the most frequent and heavier showers with the risk of thunder likely near coasts exposed to the southwest, whereas many eastern areas will have few showers. The trough will bring more organised areas of showers into Wales and the southwest during the afternoon and evening, again with hail and thunder a possibility. Scotland will be mainly cloudy tomorrow with periods of rain but eastern Scotland should become brighter later in the day. Rainfall in western and northern Scotland could be heavy and prolonged at times. Temperatures tomorrow will be rather below normal generally.

MAIN SR NO. 47 (PART 2) ISSUED 15/2235

With low M remaining a very active feature and with further development likely given the tightness of the baroclinic zone the main rain area has been extended further north in part 1 to include southern and eastern Scotland. Southerly gales over land areas could also extend further westwards across southern England than envisaged earlier.

Annex 2.5 Main synoptic review number 48 (Part 1 issued at 0345 GMT 16 October 1987).

Warnings

Land gales, thunder.

Nowcast

Rain over southwest moving from about 220 around 25 kt.

Fine mesh

Delayed because of Cyber problems previous run not good for detailed guidance.

Forecast

Low M to track north northeastwards to be near 53 N 03 W 06 GMT. Extensive area of rain associated with low M will spread northwards across northern England and southern and eastern Scotland during the morning although some heavy bursts especially over Wales and northern England with embedded thunderstorms. Southerly gales will affect many parts of southern and eastern England with easterly onshore flow affecting northeastern areas later. The heaviest rain is expected to clear southwest England soon after dawn and most of Wales during the morning to leave much of southern half of the country in clear conditions by midday, with blustery showers which could be heavy at times with thunder. Northern England will remain cloudy for much of the day with heavy rain at times which will extend into southern and eastern Scotland during the day. The area of rain in the circulation of low L will progress westwards into western Scotland with some heavy bursts of rain at times. The areas of heaviest rain will clear the far northeast this morning to leave much of the country in the clearer conditions with coastal showers. Minor troughs may give enhanced showery activity with thunder across southern parts during the night. There will be severe land gales across much of Wales and England during the first part of the day with winds moderating generally later. Temperatures rather below normal but rather cold in the wetter areas.

MAIN SR NO. 48 (PART 2) ISSUED 16/0440

Power problems at Bracknell will have prevented any fine mesh run and the coarse mesh is also delayed so model guidance unfortunately is lacking at the moment. FRONTIERS indicates a movement of 220/25 kn on the rain area over the southwest so a clearance from the southwest peninsula and much of Wales can be envisaged during the morning. The dry tongue extending northeastwards from Biscay reached across East Anglia so further heavy rain is unlikely in the southeast corner of the country. As the low tracks northwards later in the day eastern Scotland and northeast England could experience some severe northerly winds.

MAIN SR NO. 48 (PART 3) ISSUED 16/0550

However pressure falls are over Yorkshire and Lincolnshire at 05 GMT indicating the continuing northeast movement of the low pressure centre. Radar shows rainfall over southwest England generally decreasing in extent and intensity in line with earlier thoughts, so timing suggested for clearance from Wales still seemed valid. Active convection beyond 50 N 20 W suggests some heavy showers across southern districts later on in the day.

Chapter 3

SCIENTIFIC ASSESSMENT

3.1 Introduction

This chapter presents the results of investigations aimed at clarifying the reasons for the deficiencies in the numerical guidance presented to forecasters concerning the development of the storm.

In section 3.2, the dynamical characteristics of the genesis and evolution of the storm are examined, within the limits of the evidence available, to see if they were highly exceptional. Section 3.3 is concerned with the shortcomings of the operational numerical forecasts, particularly those originating from 0000 and 1200 GMT on 15 October. The objective is to determine how observations, analysis procedures or the forecast models themselves contributed to the errors. The possibility that additional useful guidance material could have been derived from the numerical integrations is briefly examined in section 3.4, and section 3.5 describes the potential usefulness of systems now being developed. Some conclusions are given in section 3.6.

3.2 Dynamical structure of storm

To understand the processes which lead to the development of the storm on 15/16 October it is necessary to consider the wider atmospheric conditions over the Atlantic and during the preceding days. At 0000 GMT on 14 October (48 hours before the storm affected the United Kingdom), the flow at upper levels over the Atlantic consisted of a strong, broad, westerly airstream between latitudes 40° and 50° N (Figure 3.1). This is fairly far south for the time of year, but not unusual. The temperature contrast between polar and tropical air was largely confined to the same latitude belt. The other feature of interest in Figure 3.1 is the trough just leaving the east coast of America. At the surface, the depression of interest was near 40° W, with a central pressure of 1003 mb (Figure 3.2), well ahead of the upper trough. During the next 24 hours the depression deepened and moved quickly eastwards. In the operational computer analysis of sea-level pressure for 0000 GMT on the 15th (Figure 3.4), there is some uncertainty because of the sparsity of observational data. Its indication of three distinct low-pressure centres is probably correct, but there is some doubt over their relative intensities. The upper trough also moved quickly eastwards, but it was still to the west of the surface depression (Figure 3.3).

During the period 0000 to 1200 GMT 15 October, the amplifying upper trough with its associated strong winds crossed the region in which there were surface pressure centres, and where the low-level baroclinicity and thermal contrasts were large. These conditions are especially favourable for the development of depressions, especially if the upper trough 'phase-locks' with a surface centre.

Small-scale jet streaks (areas of local intensification) may be embedded within the broad jet-stream flow, and influence the nature and intensity of subsequent surface development. This may have been important on this occasion, as a crucial aspect of the success or otherwise of the numerical forecasts was related to which of the three surface lows was predicted to intensify. Direct observational evidence is difficult to obtain, but the experimental forecasts discussed in section 3.3 demonstrate sensitivity to the structure of the upper flow, and in one of the better forecasts (Figure 3.5) isotach maxima can be seen propagating round the base of the trough.

In studies of a storm which developed explosively off the eastern seaboard of the USA, Uccellini *et al.* (1984, 1985) showed that a key feature was a polar jet-streak which propagated, with associated stratospheric air, down to mid-tropospheric levels. Conclusive observational evidence for a similar feature is lacking, but satellite images for the UK storm indicate that a dry slot (cloud-free zone) was visible in the cloud images and more clearly in the water-vapour imagery. This may have been associated with a deep stratospheric intrusion. The imagery during 15 October is essential for fixing the position of the frontal zone and the waves on the front because of the lack of surface observations. The satellite pictures shown in chapter 1 also show a number of other features (for instance a cloud head) which are believed to be linked to strong cyclogenesis (Böttger *et al.* 1975). However, these qualitative observations by themselves do not provide sufficient information to enable the precise nature of the evolution of the low to be predicted.

During the mature phase, on 16 October, the depression, as represented in the most successful fine-mesh forecast (see section 3.3(ii)), had a pronounced warm core below 5 km between two zones of high baroclinicity (Figure 3.6). The existence of such a feature is supported by surface observations. A pronounced low-level jet stream was situated beneath the baroclinic zone at 49.5° N at a height of 2 km (Figure 3.7). Other cross-sections show similar low-level wind maxima, and the sounding from Crawley measured a maximum speed of 103 kn at 2 km (Figure 3.8).

Many intense extratropical cyclones have been observed to have warm cores, the origin of which is the subject of scientific debate at present. One possibility is that in the occluding phase of a depression some of the warm air gets extruded from the warm sector and remains trapped at low levels in the depression, whilst the rest moves upwards and ahead of the storm. Bergeron (1928) identified such a process and termed it 'seclusion'. Another explanation is that vigorous convective ascent in the vicinity of the centre of a developing depression causes compensating subsidence outside the convective areas which leads to adiabatic warming. Although there were some reports of thunderstorms from stations on the Welsh coast during 16 October, there is little evidence that convection was sufficiently widespread to contribute significantly to this process. A third possible explanation for the relative warmth is that large fluxes of sensible and latent heat entered the storm over Biscay in association with the pre-existing strong winds. Whatever the actual process is, the fine-mesh model seems capable of representing it. Further studies of these dynamical mechanisms and their role in the formation of such storms are needed to establish the nature of the mechanisms more precisely.

In summary, though the general atmospheric conditions strongly favoured cyclonic development, no features have been identified that would have enabled the quite exceptional character of the storm to be identified at an early stage.

3.3 Causes of errors in the operational numerical forecasts

(i) *Medium-range forecasts*

The medium-period forecasts, from data times during 11 to 14 October, provided good guidance for the development of a storm. They correctly forecast the movement and intensification of the large-scale upper trough, and its relation on 15 October to the surface baroclinic zone. Details of the track, timing and intensity of the depression varied somewhat between runs but as shown in chapter 2, the Meteorological Office's global models forecasts were more consistent, and nearer the truth, than those from other centres. The forecasts from later on the 14th, however, were less accurate implying weaker winds over the south of England than did earlier forecasts. The wind strengths were critically dependent on the track of the depression, and this was forecast to be east of the true track. In some other aspects, such as rainfall over northern areas and winds in other areas, they were more accurate. In general, the medium-range forecasts of the storm were well up to the normal standards for these ranges ahead, and the main forecasting problems were associated with the forecasts produced during 15 October.

(ii) *Forecasts from 0000 GMT 15 October*

The Meteorological Office's fine-mesh model has an excellent record in forecasting rapid developments up to 36 hours ahead. As a result forecasters have come to put more weight on its guidance than on the global model. Thus its failure to predict the storm's development correctly in the forecast run with data received by 0200 GMT on 15 October was unusual, and a major factor influencing the forecasts that were issued. On the other hand the global model, run with data received by 0320 GMT, gave reasonable guidance for the storm's track and intensity over England.

The obvious most likely reasons for differences in the models' forecasts are that the analyses were significantly different. This was examined by running the fine-mesh forecast model from an interpolated global model analysis. Figure 3.9 compares the 24-hour operational forecasts from the global and fine-mesh models, and from the fine-mesh forecast using the interpolated global analysis. They can be verified against the analysis shown in Figure 1.1(f).

The run of the fine-mesh model starting from an interpolated global model analysis differs little from the global model forecast except in the central pressure of the storm, implying that the operational forecast errors in the track and timing of the system were caused by features in the fine-mesh analysis.

Figure 3.10 shows the corresponding 12-hour forecasts. They can be compared with Figure 1.1(c). Neither of the forecasts from the global analysis reproduce the individual pressure centres approaching the Brest peninsula; instead they concentrate all the development on a centre which was located where the third and last individual centre actually was and which in reality went on to become the main storm. As the horizontal separation between the centres is about 400 km, and variations on this scale cannot be adequately represented in the global model with a grid length of about 150 km, the absence of detailed structure in the forecast surface pressure field is not surprising. The operational fine-mesh forecast (Figure 3.10(b)) predicted a low in about the position of the forward centre, but it was not the centre which actually developed. Nevertheless in a number of aspects the forecast from the operational fine-mesh model is more like Figure 1.1(c) than that from the global model, a factor which highlights the difficulties of reaching correct decisions on the day.

A series of experiments, described below, culminated in a fine-mesh assimilation and forecast which was excellent in its prediction of the track and intensity of the storm over England. This forecast was used for the model diagnostics in section 3.2 and may be used here to identify the nature of errors in other forecasts. The forecast of mean-sea-level pressure is shown in Figure 3.11, and Figure 3.12 shows the forecast of 10 m wind. Like runs from the global analysis, the forecast concentrated development on the last centre though it did have significant troughing forward towards Brest, and in this aspect is superior to them. There are more substantial differences in the upper winds (cf Figures 3.5 and 3.13). The best forecast shows a series of jet streaks propagating around the upper trough, and there is no sign of the area of weakness over the Bay of Biscay which was a feature of forecasts from the global analysis.

The fine-mesh data assimilation cycle (Bell 1986) consists of four 3-hour assimilation periods starting from interpolated global model fields every 12 hours. For each cycle, data is accepted if it is within a time window ±90 minutes from the nominal analysis time. In contrast, the global model has a 6-hour cycle and a ±180 minute time-window.

The good forecast from the 0000 GMT 15 October global analysis seems to be due to observations in its last time-window; a forecast from its earlier 1800 GMT analysis had only a weak low pressure centre of 982 mb near the Dutch coast at 0000 GMT on the 16th. This window corresponds approximately to that of the last two cycles of the fine-mesh assimilation. However most observations are nominally valid for the main synoptic hours, so Table 3.1 lists the volumes of data available to the 0000 GMT cycle of the global and fine-mesh assimilations. For the former, it consists of all observations made within the period 2100 GMT on the 14th to 0300 GMT on the 15th and received before 0320 GMT on the 15th; the equivalent period and time for the fine-mesh model are 2230 GMT on the 14th to 0130 GMT on the 15th and received before 0220 GMT on the 15th.

The table and an examination of the locations of observations indicates that more satellite data, and more aircraft and ship reports, were available to the global assimilation in areas where they might have affected developments in the Bay of Biscay. By deleting the SATEM data, and the AIREP reports successively, it was established that only the latter had a significant effect on this occasion. Without the benefit of the additional aircraft data, the 24-hour global forecast for 0000 GMT on the 16th was considerably less realistic.

Almost all the additional AIREPs were for the period 0130 to 0300 GMT and, importantly, they were in the strong wind belt between 30°–40° W. (The majority of commercial trans-Atlantic flights leave North America to arrive in Europe in the early morning, and try to fly in the westerly jet.) The distribution of AIREPs (Figure 3.14), shows that most reports were at 40° W and 30° W. Additional SATEMs on the other hand were from an orbit with an overpass time of approximately 2200 GMT at 40° W, but they arrived too late to be included in the 2100 GMT cycle of the operational run. In order to ensure that the additional AIREPs were included in a revised fine-mesh forecast, as well as the additional SATEMs, the observation time-window of its 0000 GMT cycle was increased to match that of the global assimilation. The result was an improvement on the operational fine-mesh forecast for the storm over England but it was still inferior to the run from the interpolated global analysis.

Observations made before 0300 GMT continue to arrive at Bracknell after 0320 GMT. Table 3.2 shows the data volumes which were eventually available for repeat fine-mesh assimilations at 2100 GMT on the 14th and 0000 GMT on the 15th, as well as the volumes operationally available.

As already noted, potentially useful satellite data were missing from the 2100 GMT assimilation. At 0000 GMT, the extra satellite data were at 60° W and are probably not relevant. Additional ships' observations were received because many ships wait until morning to transmit their night-time reports. The increase in aircraft reports within the fine-mesh time-window is 9, but 127 if the window is expanded to 0300 GMT. A relatively large number of SATOBs (cloud motion vectors derived from satellite images at ESOC, Darmstadt) were received; however, it is recognized that care must be exercised if they are used operationally as they sometimes underestimate the strength of upper-level jet streams.

Various combinations of these data were tested. The best, which included all of them, gave a result close to the run from the interpolated global analysis. The 24-hour forecast of the centre was 964 mb over Hampshire. This compares with 958 mb over Devon using the interpolated global analysis and an actual of about 952 mb near Brest. Omitting either the SATOBs or the aircraft data between 0130 and 0300 GMT gave a shallower low. In contrast with the global assimilation experiment, this run indicated that the inclusion of SATEM data improved the prediction of the depression track.

The experiments described so far changed only the observations used in the assimilation. In addition to a different assimilating model and a different time-window for using observations, there are several other differences between the global and fine-mesh assimilations. The fine-mesh time-step is half that of the global model, so that during the assimilation, data are inserted more frequently. This is compensated for by the fine-mesh assimilation period being 3 hours, half that of the global assimilation, and by giving the observations less weight* at each time-step. The area affected directly by observations is also less in the fine-mesh assimilation.

Fine-mesh forecasts were carried out in which the insertion period, the weight, and the influence area, were increased towards the values used in the global assimilation. Some of these options were tried in combination, and for several of the observation combinations discussed above. The main conclusion was that, for this case, a 40% increase in the weight given to the observational data was beneficial; other changes had little effect.

The forecast from an assimilation using the increased weight and all the data, including aircraft reports which fell outside the normal time-window, produced the best forecast of the storm (Figures 3.11 and 3.12). The 10 m mean winds from this forecast exceeded 50 kn at three grid points in south-east England at 0600 GMT with a maximum over land of 55 kn. At the same time the model had a surface wind of 64 kn over the sea to the east of the Thames Estuary.

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* In the continuous insertion technique used by the Meteorological Office assimilation system, the background field (a forecast) is brought into near agreement with the observations by changing the former at each time-step by an amount which, formally, may be written (weight) × (observation minus background value).

Table 3.1 *Data available operationally within the fine-mesh area for the 0000 GMT cycle on 15 October*

	Fine-mesh assimilation	Global assimilation
SATEMs (500 km)	4	25
SATEMs (250 km)	0	98
SHIPs	139	163
AIREPs	34	99
DRIBUs	8	10
SATOBs	21	41
Radiosondes	153	169

Table 3.2 *Data available within the fine-mesh area for the 2100 and 0000 GMT cycles on 14/15 October*

	Operational fine-mesh assimilation	Rerun assimilation with late data
1930–2230 GMT		
SATEMs (500 km)	20	33
SATEMs (250 km)	59	150
SHIPS	76	77
AIREPs	23	23
DRIBUs	11	11
SATOBs	0	24
2230–0130 GMT		
SATEMs (500 km)	4	4
SATEMs (250 km)	0	69
SHIPS	139	244
AIREPs	34	43 (127)
DRIBUs	8	9
SATOBs	21	123
Radiosondes	153	177

It is interesting to note that the differences between the analyses for the operational fine-mesh forecast and this successful rerun, given in Figure 3.15(c) for surface pressure, Figure 3.16(c) for 500 mb height and Figure 3.17(c) for 250 mb height and wind, are broadly similar to those between the operational global and fine-mesh analyses. The surface pressure analysis which led to the successful evolution has three clear centres in the baroclinic zone south of 45° N and a surface pressure lower than the operationally determined value by 7 mb at 25° W. The changes in the analysis of the upper trough are minor both at 500 mb and 250 mb, but heights are slightly lower at the base of the trough. Much more substantial changes are evident in the wind field, with a stronger jet maximum at 40° W.

(iii) *Forecasts from 1200 GMT 15 October*

Both the global and fine-mesh models from 1200 GMT failed to deepen the low sufficiently in the early stages, and moved it on too rapidly, leading to unhelpful forecasts. A fine-mesh forecast from the global analysis did not correct this deficiency, nor did the ECMWF forecast from an analysis with an even later data cut-off.

The forecast from the global model analysis at 0000 GMT was good, whereas that from 1200 GMT was not. It is important to find out why.

Experiments were undertaken with the fine-mesh system to establish which data contributed most to the change. The fine-mesh assimilation was started from an interpolated global analysis for 0000 GMT 15 October, which was known to give a good forecast. Forecasts were run from intermediate analyses (data times 0600 and 0900 GMT). That from 0600 GMT (Figure 3.18) gave an excellent position both at 0000 and 0600 GMT on the 16th, with the low 2 mb shallower than the run from the 0000 GMT global analysis. In the forecast from 0900 GMT the low moved too quickly, but not as fast as in the 1200 GMT run. The progressive worsening of the forecast from 0600, to 0900 to 1200 GMT analyses, indicates that a single observational cause is unlikely.

Comparing the operational analysis at 1200 GMT (Figure 3.19) with the best 12-hour forecast from 0000 GMT data (Figure 3.5 and Figure 3.11), it is evident that the latter has already developed a single low of 972 mb with a good circulation at 14° W and troughing forward to Brest, while the former has a more indefinite low pressure area, more in line with the subjective analysis shown in chapter 1. In the upper air, the forecast has a stronger jet with a core of 155 kn and consequently a stronger shear on its northern flank, but unfortunately the data available at 1200 GMT are inadequate to show which is the more accurate representation (Figure 3.20). (This problem is exacerbated by the lack of many French observations.)* AIREPs at about 45° N in Biscay show maximum jet strengths of about 135 kn and they were responsible for the data assimilation producing a jet stream extending further north-eastwards. Although this appears to be a significant difference, forecasts made without aircraft data were not significantly altered, though the depression moved marginally more slowly.

Additional forecasts were carried out with different components of the observing system removed or added, but at best they gave only a marginal improvement. For example, omitting radiosonde data as well as aircraft data was marginally better than omitting aircraft data alone, as was omitting surface data in addition to AIREPs. A small positive impact was obtained by including high-level SATOBs which did slow the system slightly.

As varying the observations available was not helpful, an alternative approach was to use manually generated 'bogus' observations. The best 12-hour forecast from 0000 GMT was used as a guide in generating them, and they were assimilated along with the actual observations. In one run the analysed jet was increased by 15–20 kn, but the subsequent forecast did not quite retain all of this increase, and the impact in terms of the surface pressure field was small (a slightly deeper depression, but the same speed of movement). A run with a stronger low-level thermal gradient was rather more successful, giving a deeper system which, however, still moved too quickly. In none of the 'bogusing' experiments were the position and depth of the depression at 0000 GMT on the 16th correctly forecast. However, a test version of a modified assimilation scheme, which is being developed and is described in section 3.5(iv), gave a fine-mesh analysis for 1200 GMT 15 October which led to a very good forecast for the storm.

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* At this time a strike was affecting parts of the French service.

The test scheme was run for two 3-hour cycles, starting from the operational fine-mesh analysis for 0600 GMT 15 October, and using the same observations as available operationally. The sea-level pressure and 250 mb wind analyses from the test are shown in Figure 3.21, which can be compared with the operational analysis given in Figure 3.19. The test scheme gives a 969 mb low at 13° W compared to the operational schemes 971 mb at 11° W. The test analysis places greater emphasis on a trough near 44° N, 15° W; its pressure here is 5 mb lower. The test scheme's pattern in this region is more similar to the best forecast from 0000 GMT (Figure 3.11), and less similar to the subjective re-analysis shown in chapter 1, than is the operational scheme's pattern. However, there are very few observations and some doubt about their reliability; for example both scheme's wind analyses are consistent with an observation (shown in the bottom left of Figure 1.1(c) which the human analyst has decided to reject as a result of an assessment of all data available, including cloud pictures. It is noteworthy that, because the observation arrived late, it was not used in the operational analysis or test re-analysis. On the large scale the upper-wind analyses are similar, however, the deceleration of the jet near 13° W is somewhat greater; in this respect it is more like the best forecast from 0000 GMT. North-south cross-sections through the two analyses, and the best forecast from 0000 GMT, are shown in Figures 3.22, 3.23 and 3.24. They cut through the trough near 44° N, but intersect more obliquely the wave drawn by the human analyst on the basis of cloud imagery near 42° N. Differences are subtle; in most features the analyses are more similar than either is to the forecast. However, with respect to the vertical motion, the test scheme is more like the forecast. The analyses show the trough to have a frontal structure characterized by the temperature gradient, vertical motion, and the change from westerly to easterly wind component near 44° N. This front is under what in the upper atmosphere is a dry slot, and seems to be related to the cloud head visible to the north in the imagery; it is distinct from the front placed by the human analyst near 42° N on the basis of the imagery.

The sequence of sea-level pressure forecasts obtained from the test scheme's analysis is shown in Figure 3.25. This can be compared with Figure 2.10, the operational fine-mesh forecast, and Figure 3.11, the best forecast obtained from a 0000 GMT 15 October analysis. The track of the forecast from the test analysis is very slightly to the north of the actual track, but the guidance which this forecast would have given a forecaster was excellent. The mean surface wind forecasts are shown in Figure 3.26. They can be compared with Figure 2.12, the operational fine-mesh forecast, and Figure 3.12, the best forecast from a 0000 GMT analysis. The timing and area of the strong winds are well indicated. The maximum strengths are less than those in Figure 3.12, being 30, 35 and 40 kn over land at 0000, 0300 and 0600 GMT 16 October. These mean wind speeds over land from the forecast model are still exceptionally high and little below what was measured.

As the model humidities agree with the satellite cloud positions, and the computer analyses are consistent with available observations, the location of a depression near 44° N, 13° or 14° W at 1200 GMT 15 October may indeed be correct. Despite the success of the forecast, it should be noted that in root-mean-square terms the test analysis fitted the available observations less closely than the operational analysis. It therefore cannot be concluded that the forecast was accurate in all respects, and the safer conclusion at this stage is that in the development of the storm there was a very large sensitivity to the details of the three-dimensional atmospheric structure, which were not resolved by the available observations.

3.4 Utility of additional numerical guidance

Given the crucial discrepancy between the global and fine-mesh forecasts from 0000 GMT on the 15th, it would clearly have been helpful to try to resolve this on the day by an additional run from, for example, 0600 GMT. As has been noted, in this case an 0600 GMT fine-mesh run gives an accurate forecast of the storm (Figure 3.18).

As discussed in chapter 2, a major task of the forecaster when faced with numerical forecasts which are in disagreement, is to compare them with each other and with observations early in the forecast, to help decide which is to be believed. Improved interactive graphical display facilities are being developed to make this task easier to carry out effectively. For instance Figure 3.27 indicates immediately that the global analysis for 0000 GMT 15 October is placing greater emphasis on the centre at 30° W, whereas the fine-mesh is developing the one at 20° W. This difference was noted, without the difference map, by the forecaster at the time and mentioned in the synoptic review (Annex 2.1 of chapter 2).

For the good forecasts, output at 3-hourly intervals (e.g. Figure 3.12), instead of the current 6-hourly intervals of the operational charts, aids detailed forecasting, for instance of the very strong westerlies in the channel. Three-hourly information is currently available to the forecaster on a VDU in digital form; graphical representation would make rapid assimilation of the information easier. During the earlier stages of this storm, frequent charts, displayed in succession, would have conveyed to the forecaster which centre the numerical forecast was developing, and its track.

Maps of potential vorticity, on isentropic surfaces, can help the forecaster understand the dynamical causes of development in forecasts (Hoskins *et al.* 1985). Although in this case the forecaster was not in doubt about whether a development would occur, such aids to understanding are important; anything leading to a more rapid grasp of the situation by the forecaster is of benefit.

Vertical cross-sections of wind (e.g. Figure 3.7) would have helped emphasize the likelihood of very strong gusts. It appears in this case that the maximum gusts at the ground were about equal in strength to the low-level jet. The empirical gust-ratio statistics, discussed in chapter 1, would have given a reasonable estimate of the maximum gust. However, this is not always the case, and development of a more theoretically based algorithm using the detailed structure of the numerical forecast could warn forecasters about damaging winds.

3.5 Effect of systems currently under development

The Meteorological Office is developing improvements to its forecasting system. This case has been, and will continue to be, used to test them. In this section early tests of systems currently under development are briefly reviewed in order to give some idea of potential future improvements. It must be emphasized that the results are preliminary; considerable further work is needed before some of the systems can become operational.

(i) *Mesoscale model*

The mesoscale model is for use in preparing forecasts up to 18 hours ahead, the aim being to provide guidance to local forecasters on surface temperature and wind, low cloud, precipitation and visibility. It is currently run twice a day using boundary conditions derived from the fine-mesh model forecasts starting at noon and midnight. Its horizontal resolution is 15 km and it has 5 levels in the lowest kilometre, permitting some detail in the treatment of boundary-layer structure. Figure 3.28 shows the 24-hour forecast for 0000 GMT 16 October at full resolution. As expected the general evolution follows the fine-mesh model forecast. However, the wind speeds predicted over land compare well with the general level of mean speeds reported at the height of the storm. It does not reproduce the highest speeds and no attempt has as yet been made to diagnose gusts.

(ii) *Higher resolution fine-mesh model*

A higher resolution version of the fine-mesh model is expected to become operational in 1988. Higher resolution should allow a more accurate description of frontal processes, and therefore the main improvement is expected to be in forecasts of precipitation. Where topographic forcing is significant, or when frontal processes contribute significantly to the dynamical evolution, improved wind forecasts should also be obtained. No data assimilation scheme is yet available for the model, so initial conditions are obtained by interpolation from the global analysis.

Forecasts were made from data times 0000 and 1200 GMT 15 October with a horizontal grid length of 40 km, i.e. just over half that of the operational fine-mesh. As expected, the evolutions of these forecasts were similar to those with the operational fine-mesh model using the global analysis, and with the operational global forecast; however there is extra detail in the wind fields from the higher resolution forecast (Figure 3.29), and the depression is made more intense.

(iii) *Local-Area Satellite Soundings*

TIROS satellite data for orbits near the United Kingdom are picked up by the receiving station at Lasham. By processing the Local-Area Satellite Soundings (LASS), higher resolution and more timely soundings can be produced than are available over the global telecommunication system as SATEM reports. Two processing methods are available. The first, based on techniques developed in the USA for processing TIROS data, but with locally derived calibration coefficients and other modifications, uses a statistical method and a first-guess profile based on a sample of radiosonde soundings. The second uses a physically based method with a first-guess taken from a fine-mesh model forecast.

The impacts of both sets of retrievals were tested on the fine-mesh assimilation leading to the 1200 GMT 15 October analysis discussed in section 3.3(iii). The observations available during this period (processed using the statistical method) are shown in Figure 3.30. Retrievals using the statistical method were unfortunately influenced by systematic errors affecting the two swaths of data. Coincident retrievals at the swath boundary (separated in time by 90 mins) were as much as 10°C different. The western pass is probably too cold (co-located LASS and NESDIS (US) SATEMs differed by as much as 25 dam in the 1000–500 mb thickness). The forecast first-guess retrievals using an operational forecast reflected the errors in the model fields. This effect is well recognized and techniques have been proposed for taking it into account at the analysis stage, but they have not yet been implemented.

Because of their high horizontal resolution, shown clearly in Figure 3.30, these data are potentially of great value but improvement in methods of using them is needed. For the present case, the retrievals were not helpful.

(iv) *Analysis Correction assimilation system*

A new assimilation scheme, known as the Analysis Correction scheme, is being developed. Its basic structure is similar to that of the operational scheme, but its weighting and spreading of data are different. These differences are important in:

(a) the handling of off-time data such as AIREPs, which are processed at their valid time rather than the nominal analysis time, and

(b) the treatment of sparse data which should be fitted with less disruption to the detail in the forecast background.

New techniques for using the LASS retrievals discussed above are being developed as part of this scheme, but are not yet ready for testing.

A 2-cycle rerun of the global version, like the operational global scheme, gave a good forecast from 0000 GMT. A fine-mesh version of the scheme which is being developed was tested on the assimilation leading to 0000 GMT on the 15th. Results were slightly worse than the corresponding run with the operational assimilation. The test of the fine-mesh version of the assimilation for 1200 GMT 15 October has already been described in section 3.3(iii). It gave the only analysis so far obtained for that time which leads to a good forecast of the storm.

3.6 Conclusions

The storm which crossed the south of England during the night of 15/16 October 1987, developed when an upper-level trough caught up with a strong frontal zone on 15 October. The existence of this development region was well forecast by numerical models several days in advance. Details of the features within this large-scale situation were crucial for determining the track, timing and intensity of the storm, and they were less consistently forecast. In contrast with the global model, the fine-mesh forecast from 0000 GMT on the 15 October did not give a good prediction of the storm's track and intensity over England because of incorrect details in its initial conditions. Aircraft reports from the Atlantic between 0130 and 0300 GMT, which were too late for the operational analysis, would have provided much of the necessary detail; more would have come from satellite temperature soundings which arrived too late for the previous 2100 GMT analysis. A forecast based on the subsequent 0600 GMT analysis, which incorporated these late data as well as the 0600 GMT observations, would have provided excellent guidance to the development of the storm.

Neither of the two operational model forecasts from 1200 GMT predicted the storm adequately, but a fine-mesh forecast from a new assimilation scheme which is being developed did; the reasons for this are still being resolved. In the development of the storm there was a very large sensitivity to the details of the three-dimensional atmospheric structure which were not resolved by the available observations.

High-resolution models gave a better prediction of the local severity of the storm.

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Uccellini, L.W., Keyser, D., Brill, K.F. and Wash, C.H.	1985	The President's Day cyclone of 18–19 February 1979: influence of upstream trough amplification and associated tropopause folding on rapid cyclogenesis. *Mon Weather Rev*, **113**, 962–988.

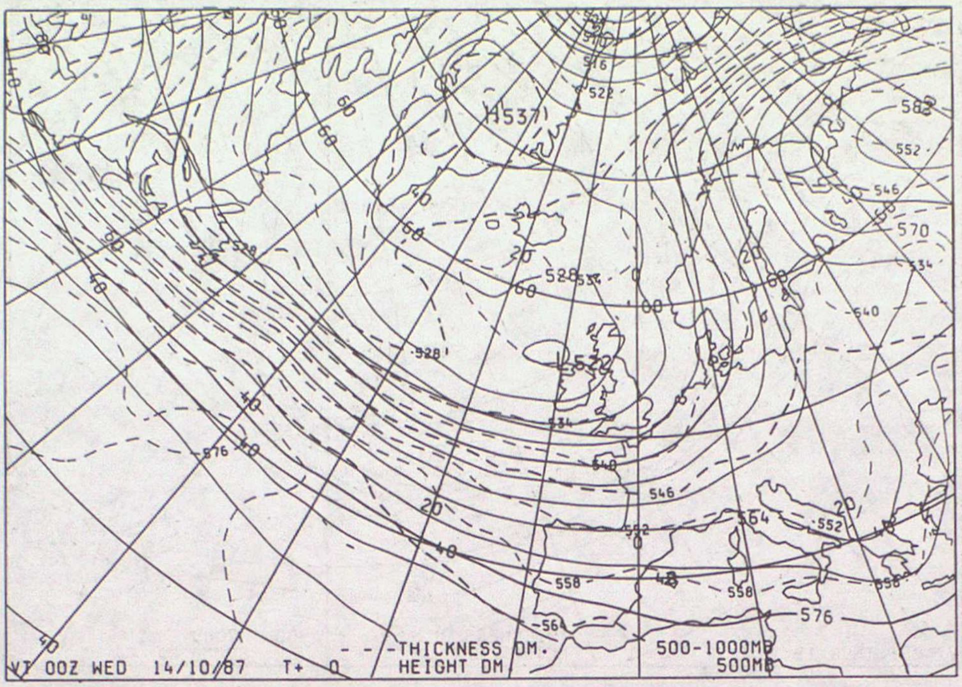

H537
L522
582
552
546
570
534
540
528
576
546
548
564
552
558
558
576
56
VT 00Z WED 14/10/87 T+ 0
- - -THICKNESS DM.
HEIGHT DM.
500-1000MB
500MB

Figure 3.1 0000 GMT 14 October 500 mb height (solid lines, contour interval 6 dam) and 1000–500 mb thickness analysis (dashed lines, contour interval 6 dam), from the operational global assimilation.

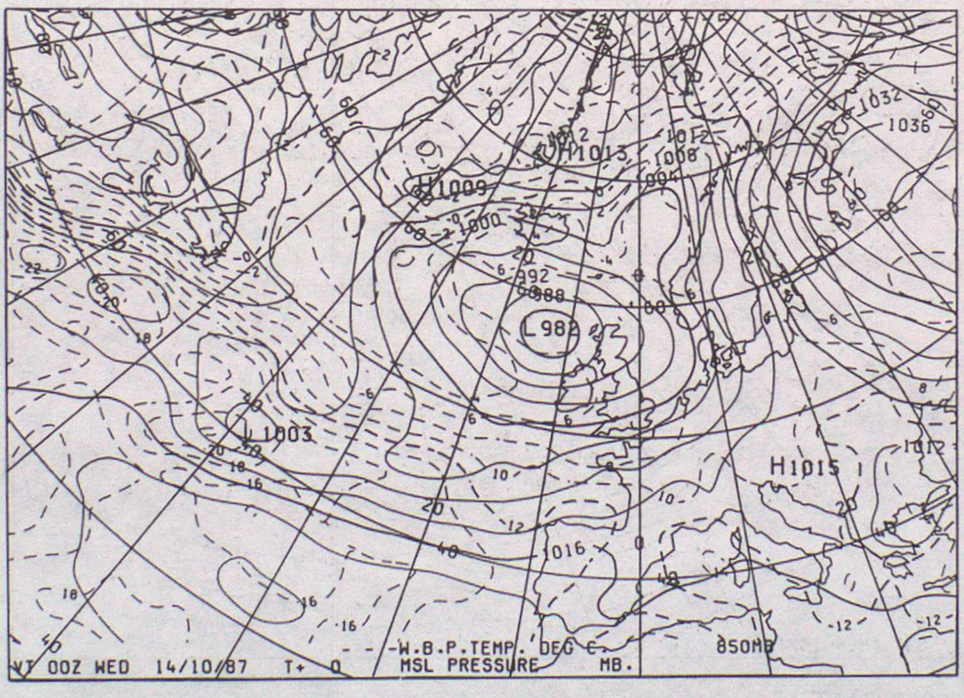

H1013
H1009
1000
992
988
L982
1012
1008
1004
1032
1036
L1003
H1015
1012
1016
VT 00Z WED 14/10/87 T+ 0
- - -W.B.P.TEMP. DEG C.
MSL PRESSURE MB.
850MB

Figure 3.2 0000 GMT 14 October sea-level pressure analysis (solid lines, contour interval 4 mb) and 850 mb wet-bulb potential temperature (dashed lines, contour interval 2°C), from the operational global assimilation.

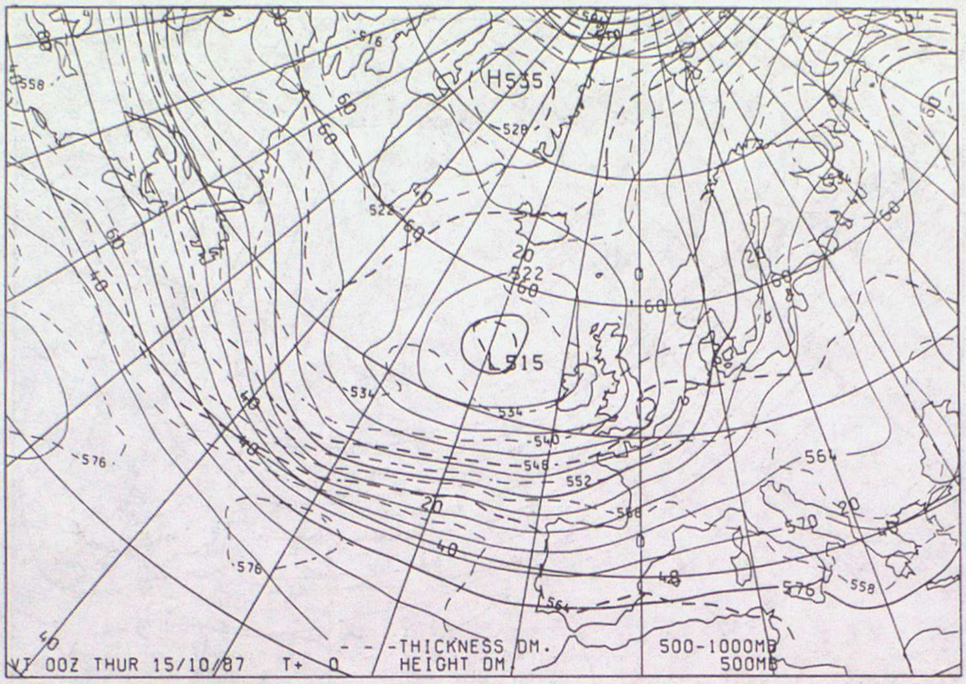

H535
L515
VT 00Z THUR 15/10/87 T+ 0
- - -THICKNESS DM.
HEIGHT DM.
500-1000MB
500MB

Figure 3.3 0000 GMT 15 October 500 mb height (solid lines, contour interval 6 dam) and 1000–500 mb thickness analysis (dashed lines, contour interval 6 dam), from the operational global assimilation.

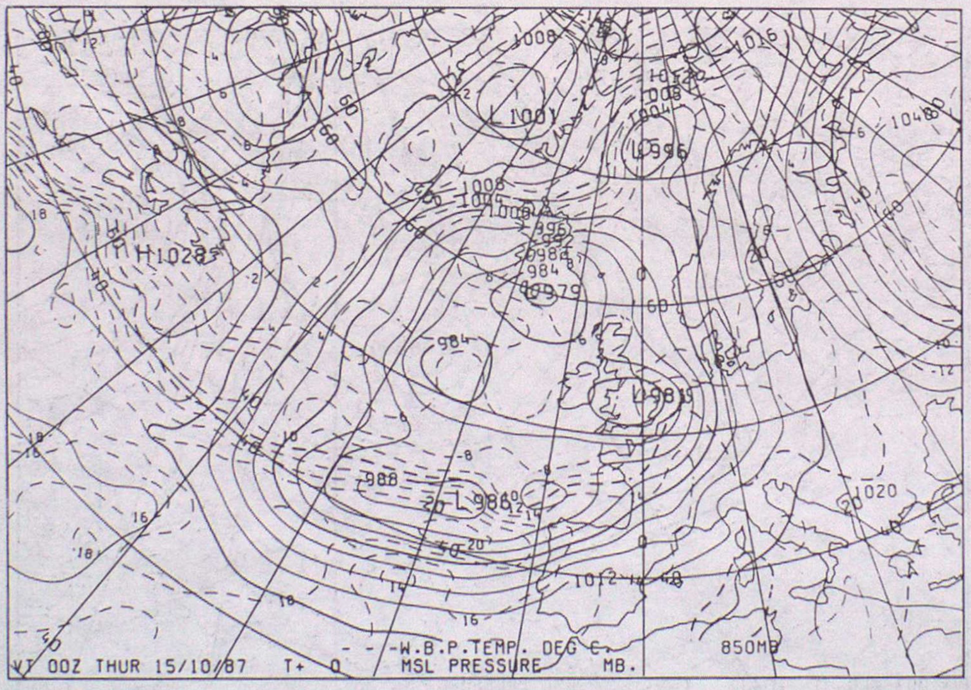

H1028
L1001
L996
L979
L981
L986
1020
1048
VT 00Z THUR 15/10/87 T+ 0
- - -W.B.P.TEMP. DEG C.
MSL PRESSURE MB.
850MB

Figure 3.4 0000 GMT 15 October sea-level pressure analysis (solid lines, contour interval 4 mb) and 850 mb wet-bulb potential temperature (dashed lines, contour interval 2°C), from the operational global assimilation.

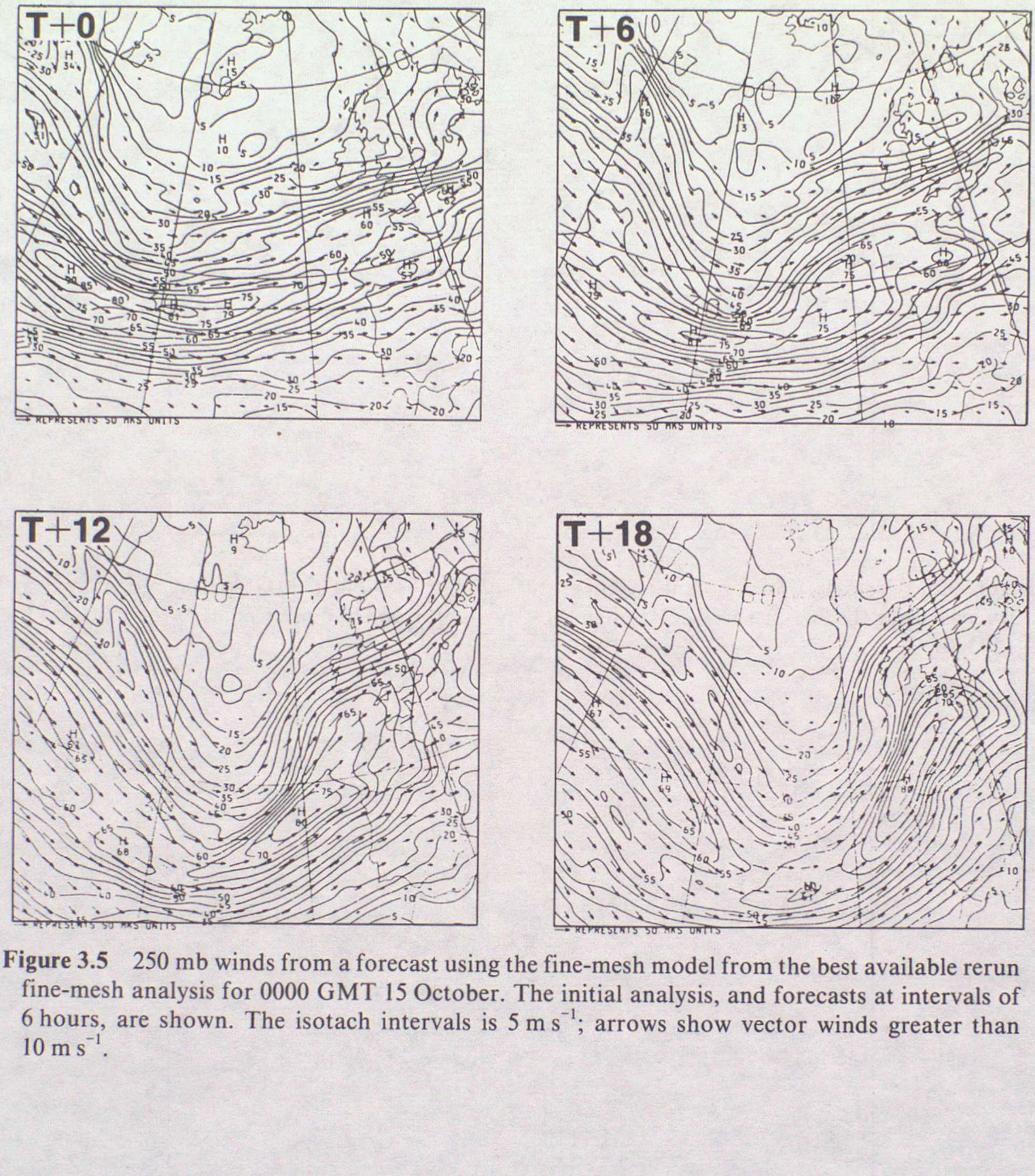

T+0
T+6
T+12
T+18
→ REPRESENTS 50 MKS UNITS

Figure 3.5 250 mb winds from a forecast using the fine-mesh model from the best available rerun fine-mesh analysis for 0000 GMT 15 October. The initial analysis, and forecasts at intervals of 6 hours, are shown. The isotach intervals is 5 m s^{-1}; arrows show vector winds greater than 10 m s^{-1}.

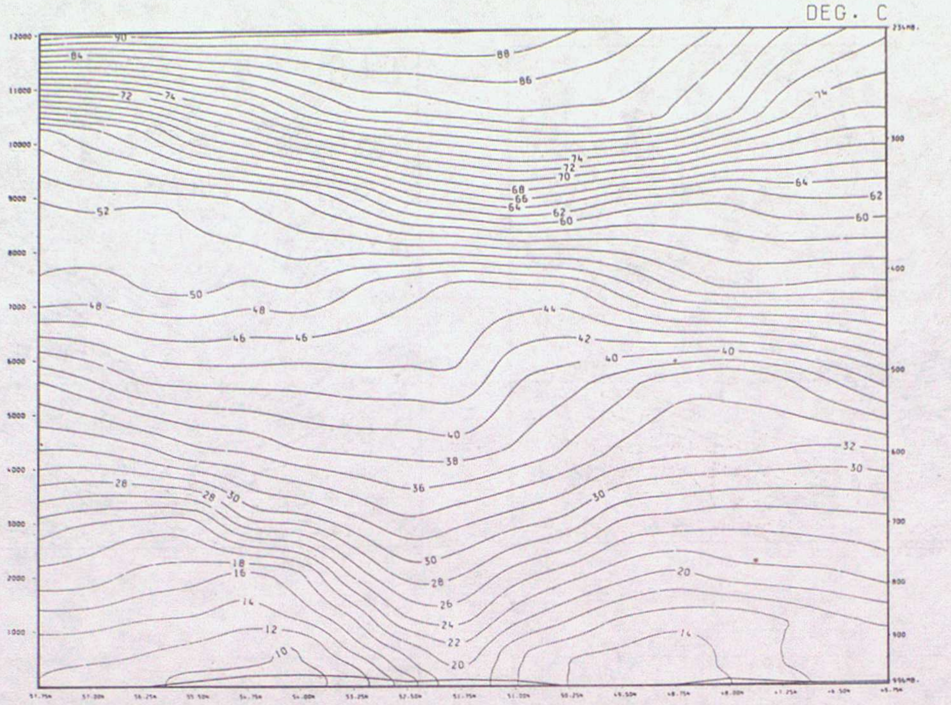


Figure 3.6 Cross-section of potential temperature along 1.87° W at 0300 GMT 16 October from a forecast using the fine-mesh model from the best available rerun fine-mesh analysis for 0000 GMT 15 October.

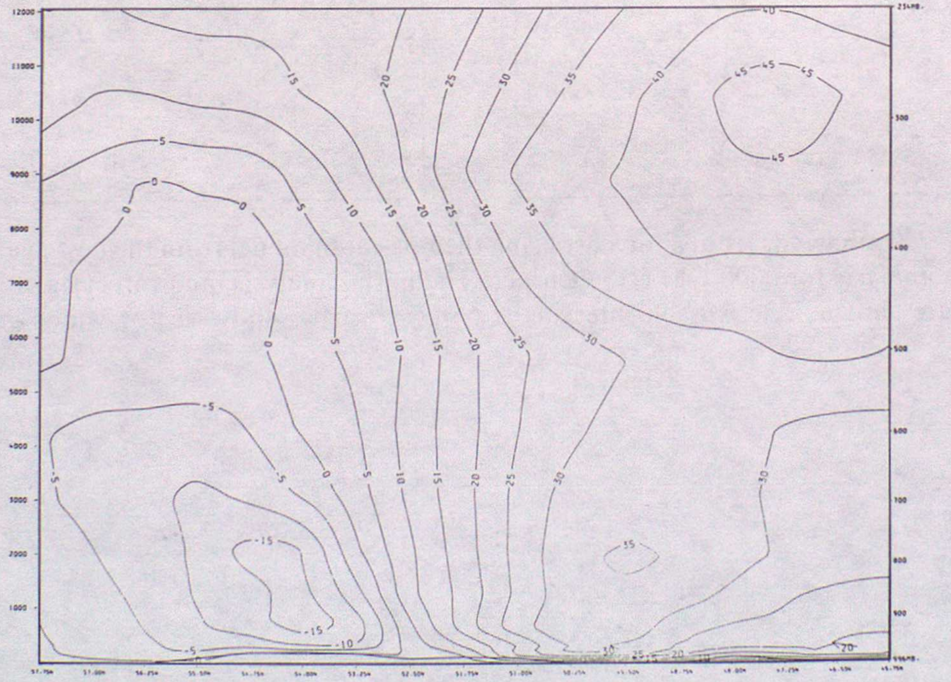


Figure 3.7 Cross-section of wind component perpendicular to Figure 3.6, along 1.87° W at 0300 GMT 16 October from a forecast using the fine-mesh model from the best available rerun fine-mesh analysis for 0000 GMT 15 October.

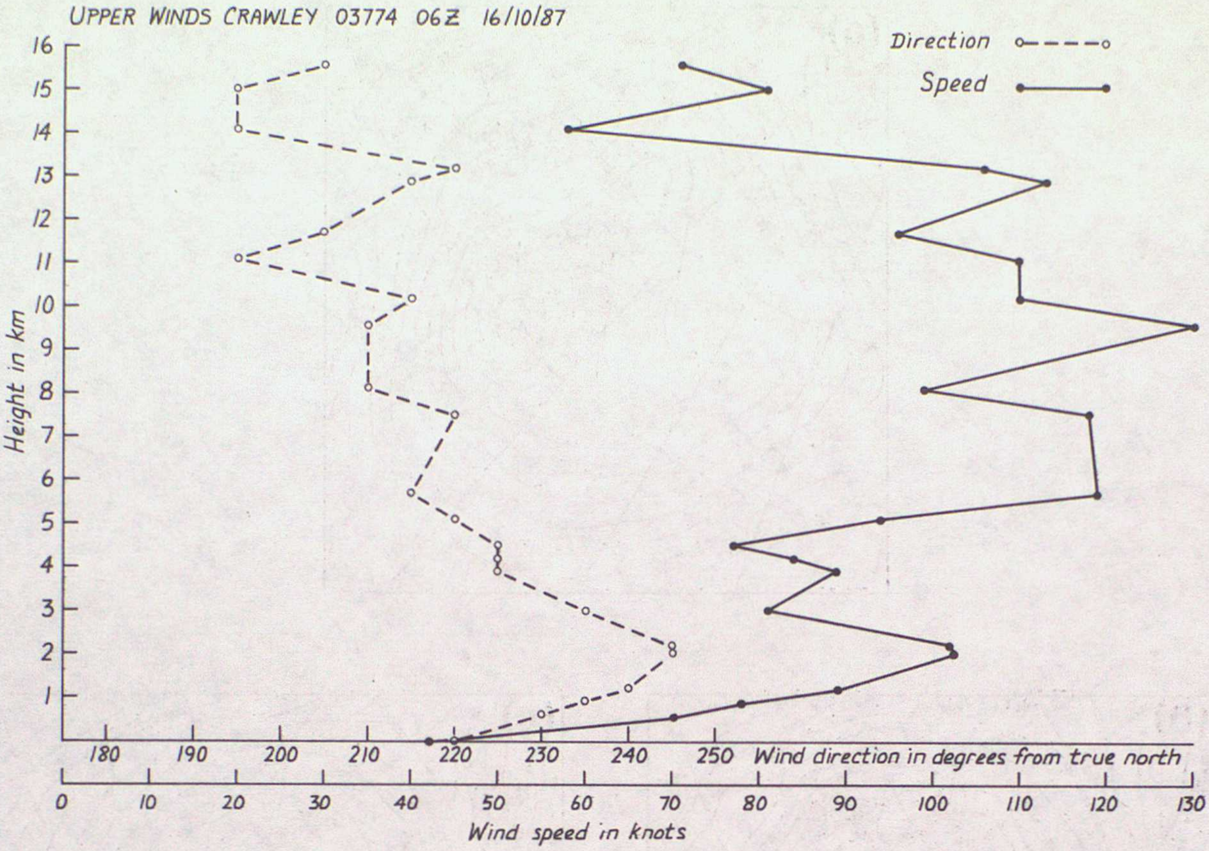


Figure 3.8 0600 GMT 16 October wind sounding from Crawley (51.2° N, 0.2° W).

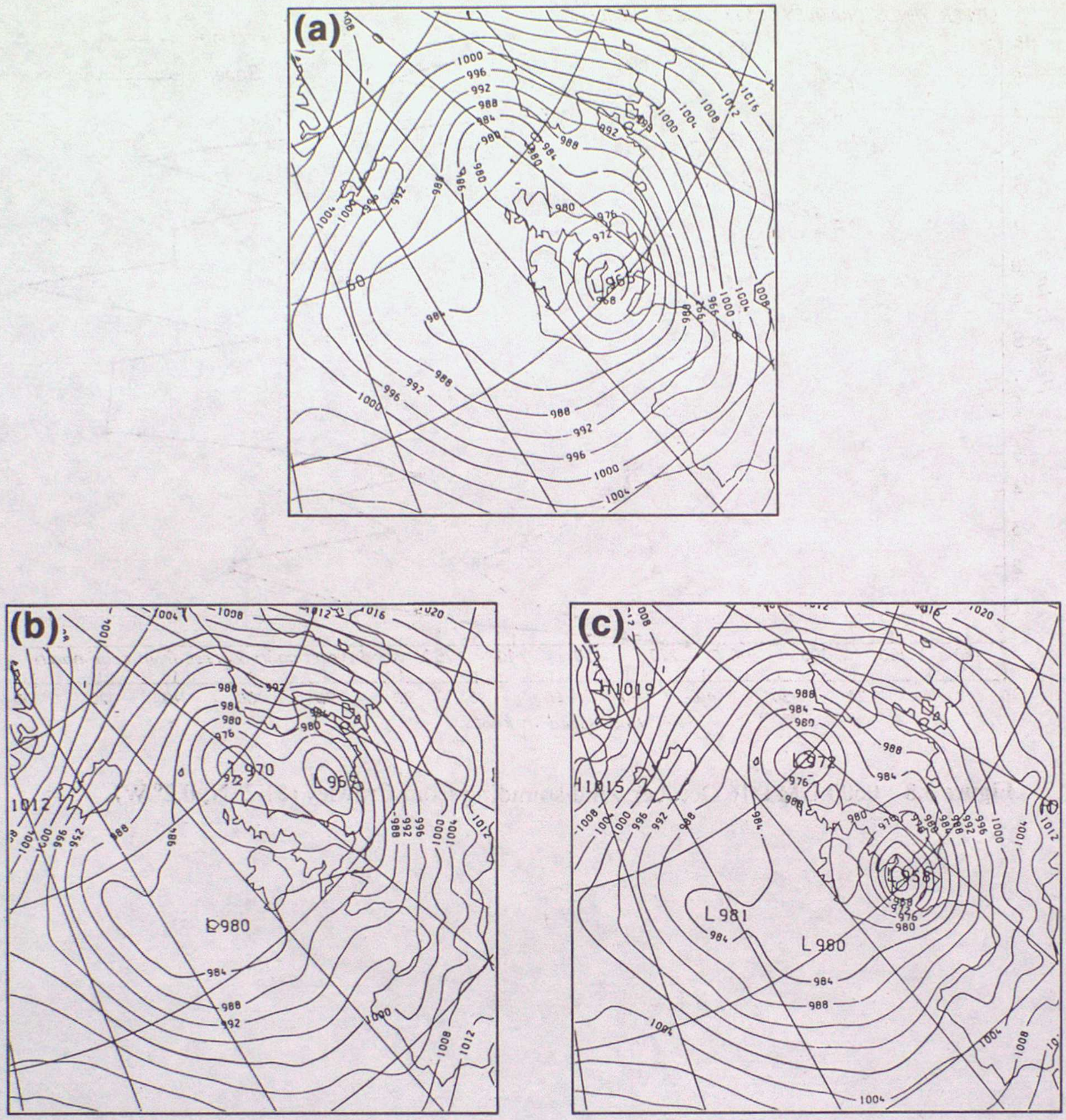

(a)
L 965
(b)
L 970
L 968
L 980
(c)
H 1019
H 1015
L 972
L 958
L 981
L 980

Figure 3.9 Sea-level pressure forecasts valid at 0000 GMT 16 October, from analyses for 0000 GMT 15 October: (a) operational global, (b) operational fine-mesh and (c) fine-mesh forecast from the operational global analysis.

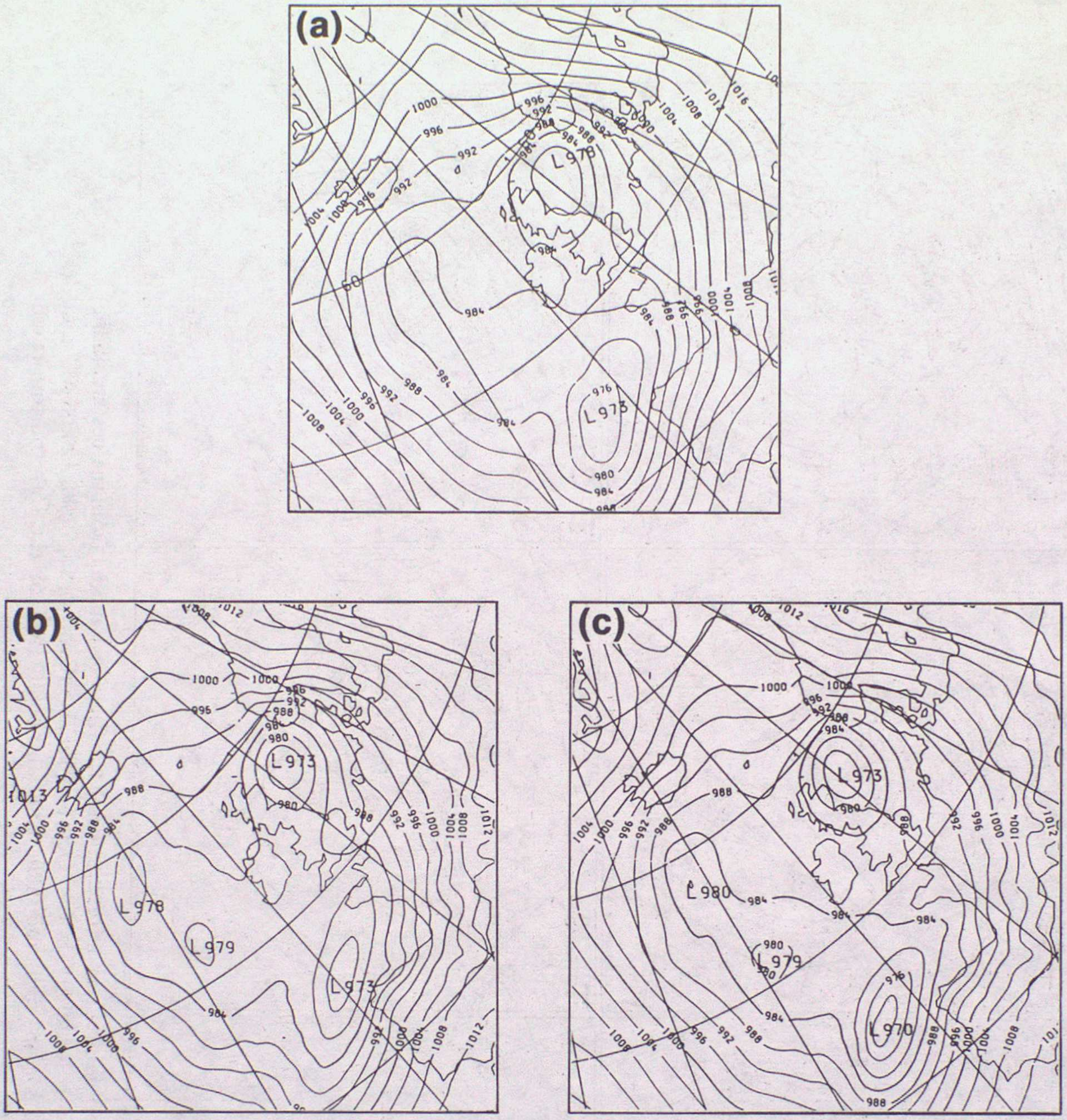

(a)
L 978
L 973
60
(b)
L 973
L 978
L 979
L 973
1013
(c)
L 973
L 980
L 979
L 970

Figure 3.10 Sea-level pressure forecasts valid at 1200 GMT 15 October, from analyses for 0000 GMT 15 October: (a) operational global, (b) operational fine-mesh and (c) fine-mesh forecast from the operational global analysis.

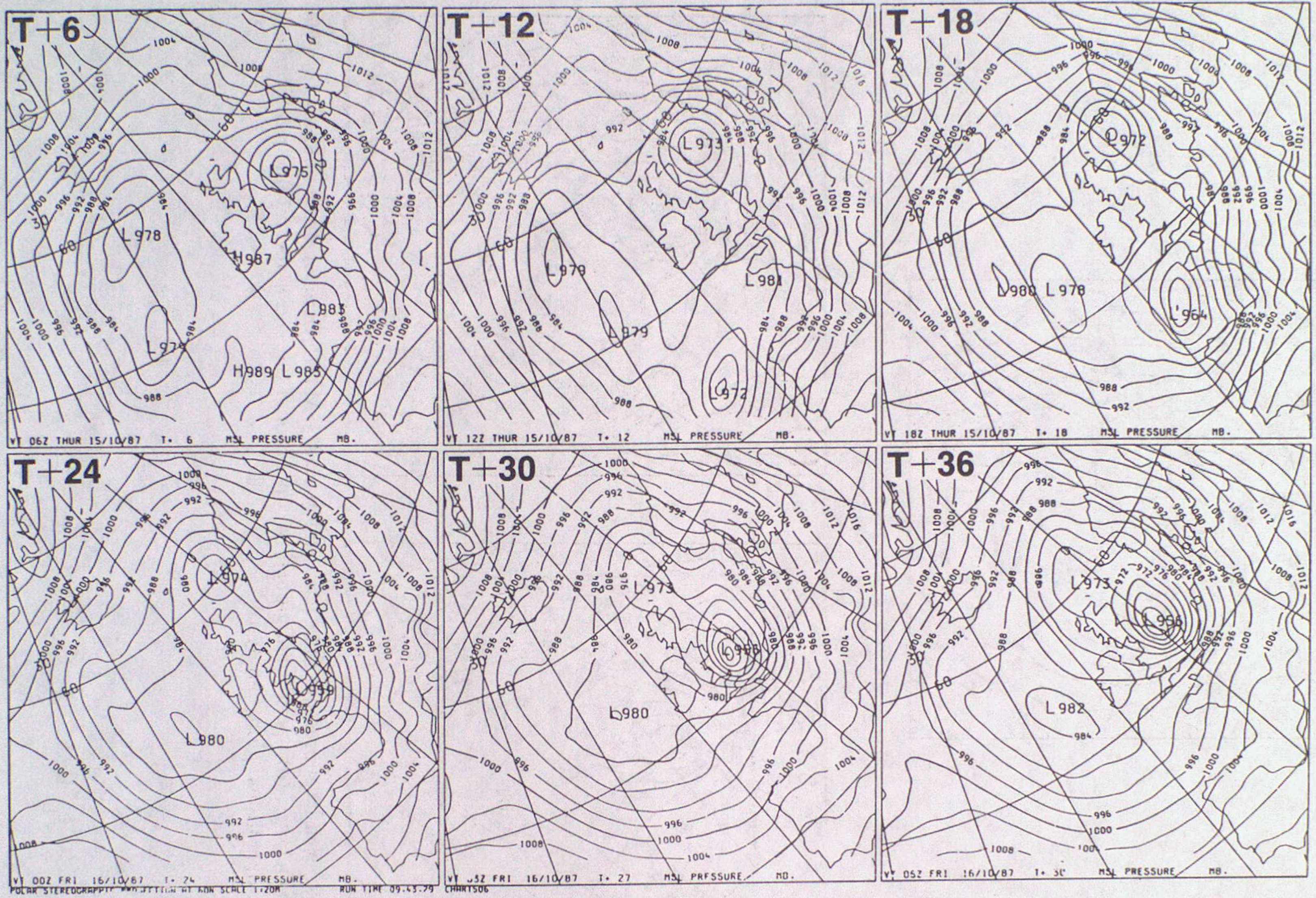

T+6
L975
L978
H987
L985
L979
H989 L985
VT 06Z THUR 15/10/87 T+ 6 MSL PRESSURE MB.
T+12
L973
L979
L981
L979
L972
VT 12Z THUR 15/10/87 T+ 12 MSL PRESSURE MB.
T+18
L972
L980 L978
L964
VT 18Z THUR 15/10/87 T+ 18 MSL PRESSURE MB.
T+24
L974
L959
L980
VT 00Z FRI 16/10/87 T+ 24 MSL PRESSURE MB.
POLAR STEREOGRAPHIC PROJECTION AT 60N SCALE 1:20M
RUN TIME 09.43.29
T+30
L973
L958
L980
VT 03Z FRI 16/10/87 T+ 27 MSL PRESSURE MB.
CHARTS06
T+36
L973
L958
L982
VT 06Z FRI 16/10/87 T+ 30 MSL PRESSURE MB.

Figure 3.11 Sea-level pressure from a forecast using the fine-mesh model from the best available rerun fine-mesh analysis for 0000 GMT 15 October. Fields are shown for 0600, 1200 GMT and 1800 GMT on the 15th (top row), and 0000, 0300 and 0600 GMT on the 16th (bottom row). Contour interval 4 mb.

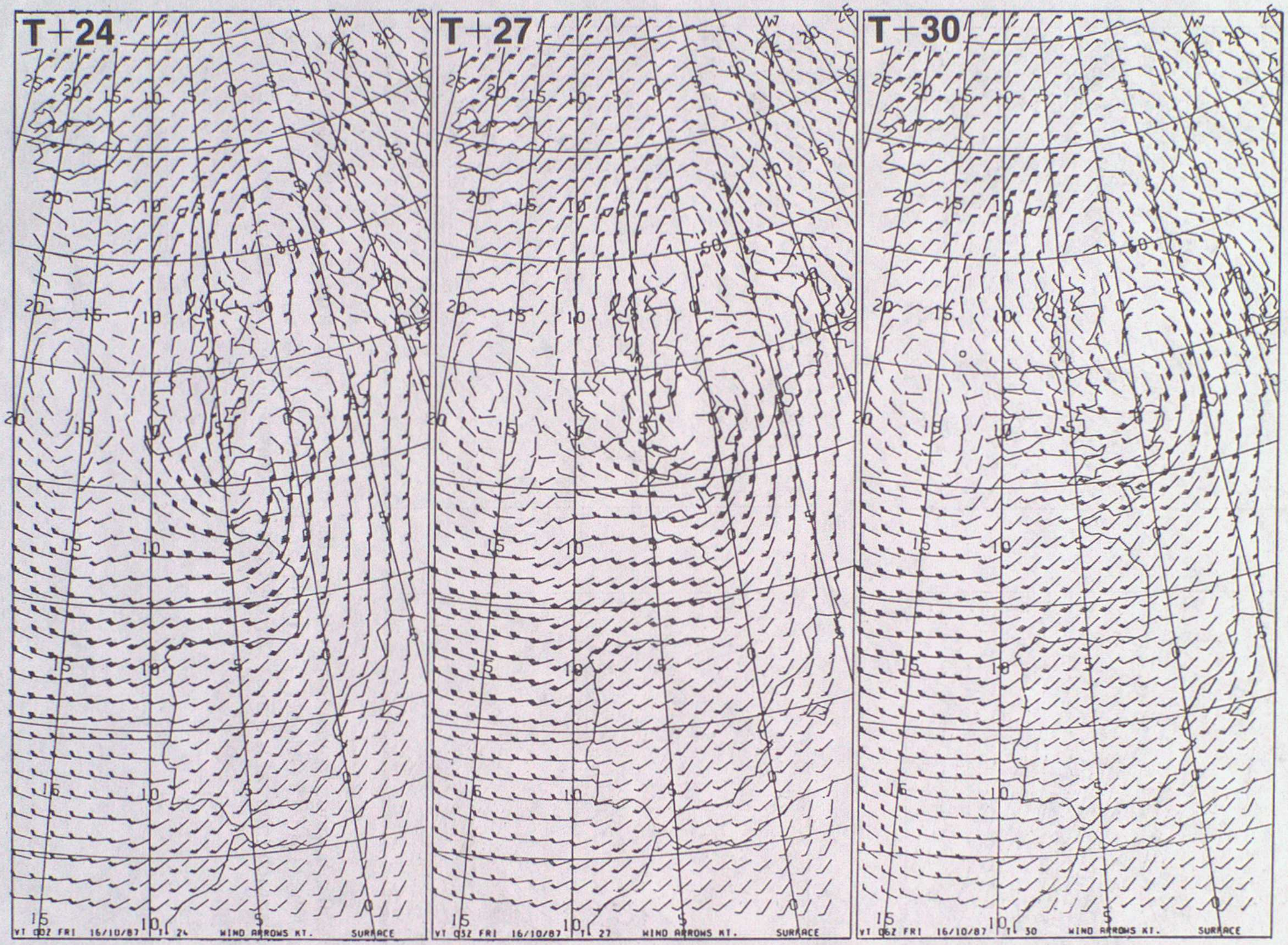

T+24
T+27
T+30
VT 00Z FRI 16/10/87 T+ 24 WIND ARROWS KT. SURFACE
VT 03Z FRI 16/10/87 T+ 27 WIND ARROWS KT. SURFACE
VT 06Z FRI 16/10/87 T+ 30 WIND ARROWS KT. SURFACE

Figure 3.12 Surface wind forecasts from a forecast using the fine-mesh model from the best available rerun fine-mesh analysis for 0000 GMT 15 October. Fields are shown for 0000, 0300 and 0600 GMT on the 16th. Each full barb represents 10 kn.

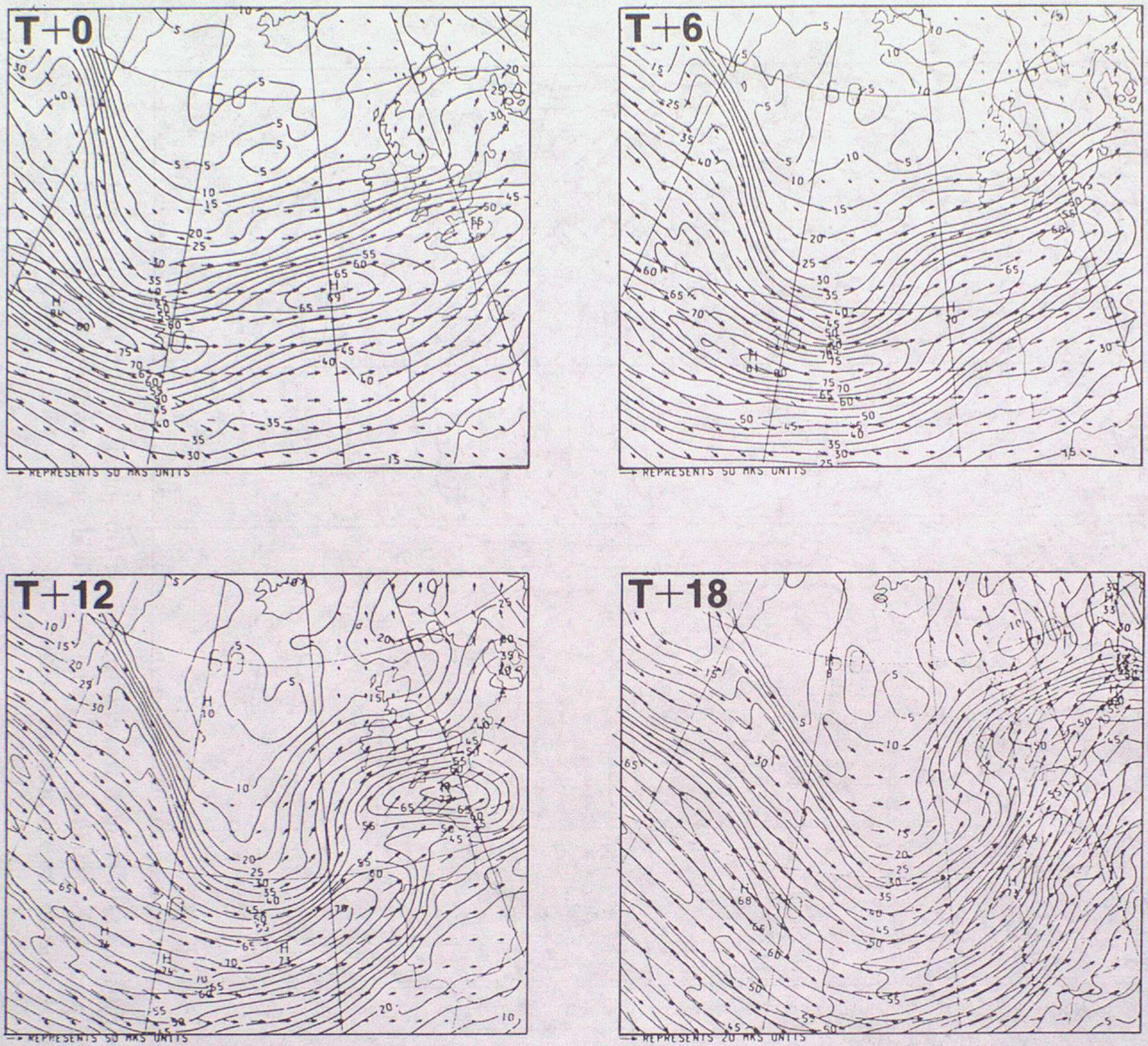

T+0
T+6
T+12
T+18
→ REPRESENTS 50 MKS UNITS
→ REPRESENTS 50 MKS UNITS
→ REPRESENTS 50 MKS UNITS
→ REPRESENTS 20 MKS UNITS

Figure 3.13 250 mb winds from a forecast using the fine-mesh model from the operational global analysis for 0000 GMT 15 October. The initial analysis, and forecasts at intervals of 6 hours, are shown. The isotach interval is 5 m s^{-1}; arrows show vector winds greater than 10 m s^{-1}.

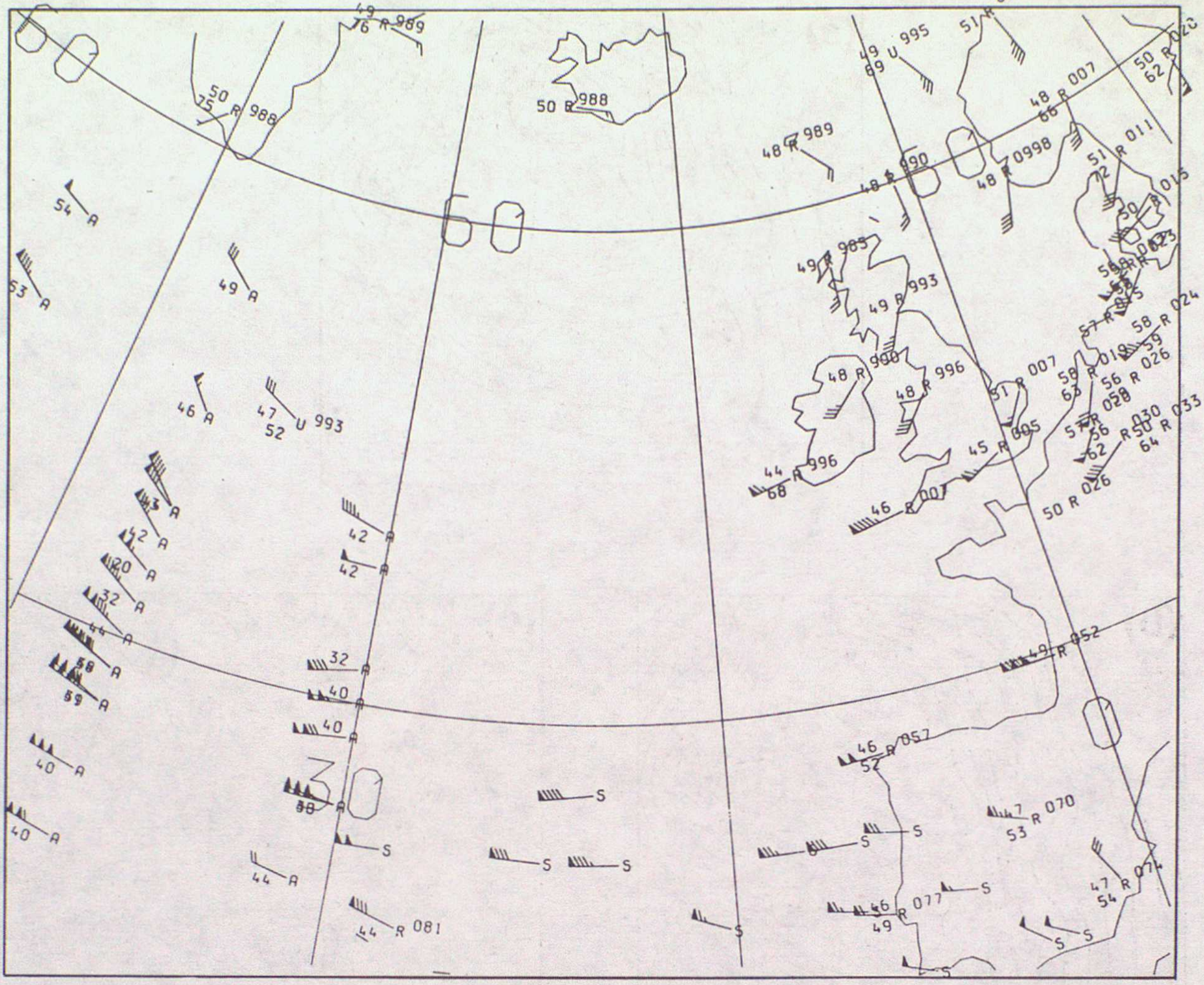
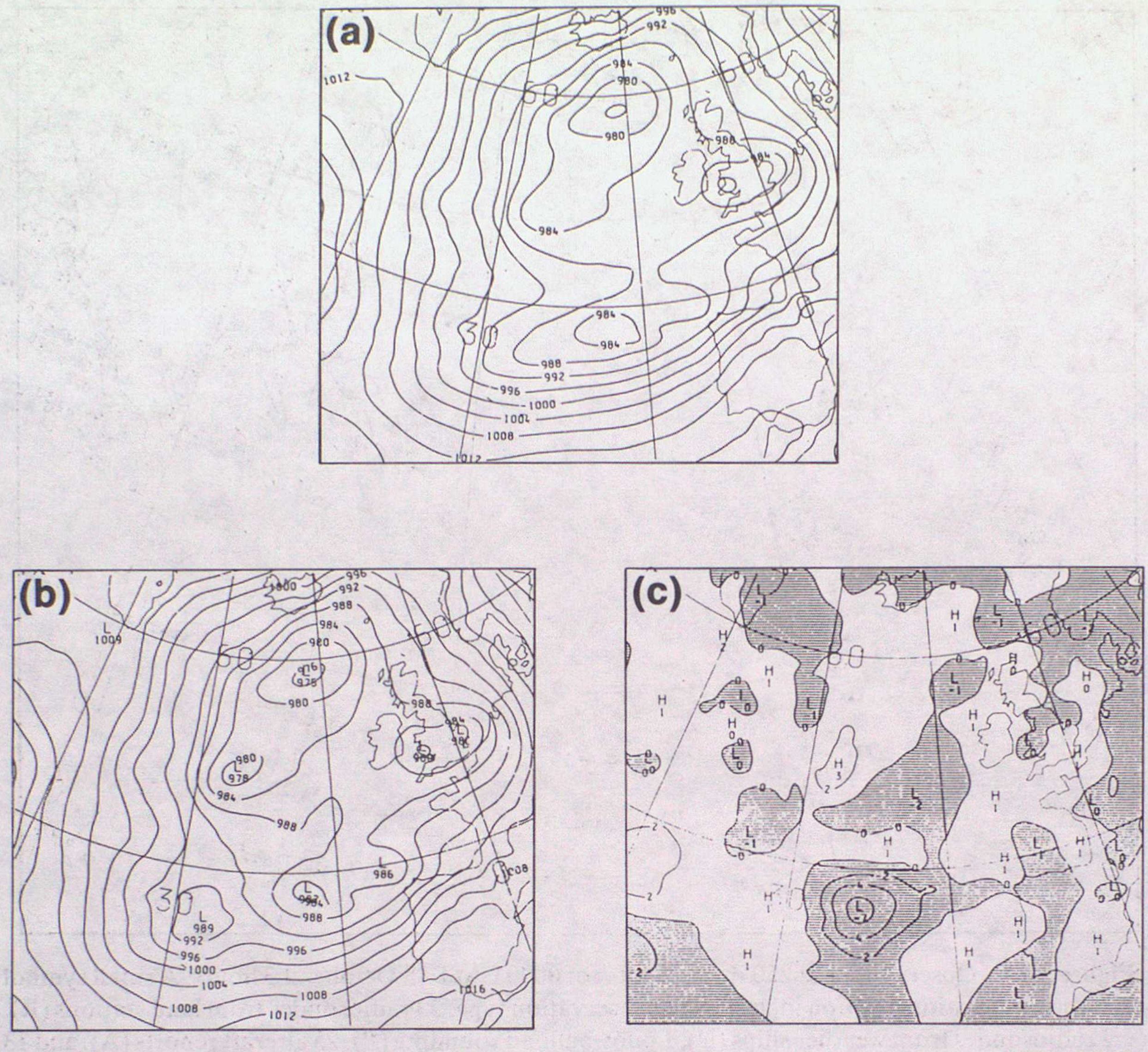

60
30
49 76 R 989
50 75 R 988
50 R 988
48 R 989
48 R 990
49 69 U 995
51 R 008
48 66 R 007
50 62 R 020
48 R 0998
51 72 R 011
54 A
53 A
49 A
46 A
47 52 U 993
49 R 985
49 R 993
48 R 990
48 R 996
44 68 R 996
46 R 001
51 R 007
45 R 005
58 R 024
58 R 026
56 R 026
50 R 026
64 R 033
42 A
20 A
32 A
42
32
40
40 A
44 A
44 R 081
49 R 052
46 52 R 057
47 53 R 070
46 49 R 077
47 54 R 074
S

Figure 3.14 Observations at 250 mb ±25 mb, for 0000 GMT 15 October ±3 hours. A small symbol at the observation position identifies the observation type: 33 radiosondes from land stations (R), 2 radiosondes from weather ships (U), 1 pilot-balloon sounding (P), 25 aircraft reports (A), and 13 cloud-motion winds were within the area shown. Some of the aircraft reports at 40° W and 30° W coincide and are overplotted.


(a)
1012
996
992
984
980
980
988
984
984
984
984
988
992
996
1000
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1008
1012
60
30
(b)
L
1009
1000
996
992
988
984
980
976
978
980
978
984
988
988
984
986
989
986
1008
L
983
984
988
L
989
992
996
996
1000
1004
1008
1008
1012
1016
60
30
(c)
H
L
0
1
-1
2
-2
3
60

Figure 3.15 (a) Operational fine-mesh analysis of sea-level pressure valid at 0000 GMT 15 October, (b) best rerun analysis from fine-mesh assimilation with extra observations and increased weight to observations (contour interval 4 mb) and (c) difference (a) minus (b), negative values shaded, contour interval 2 mb.

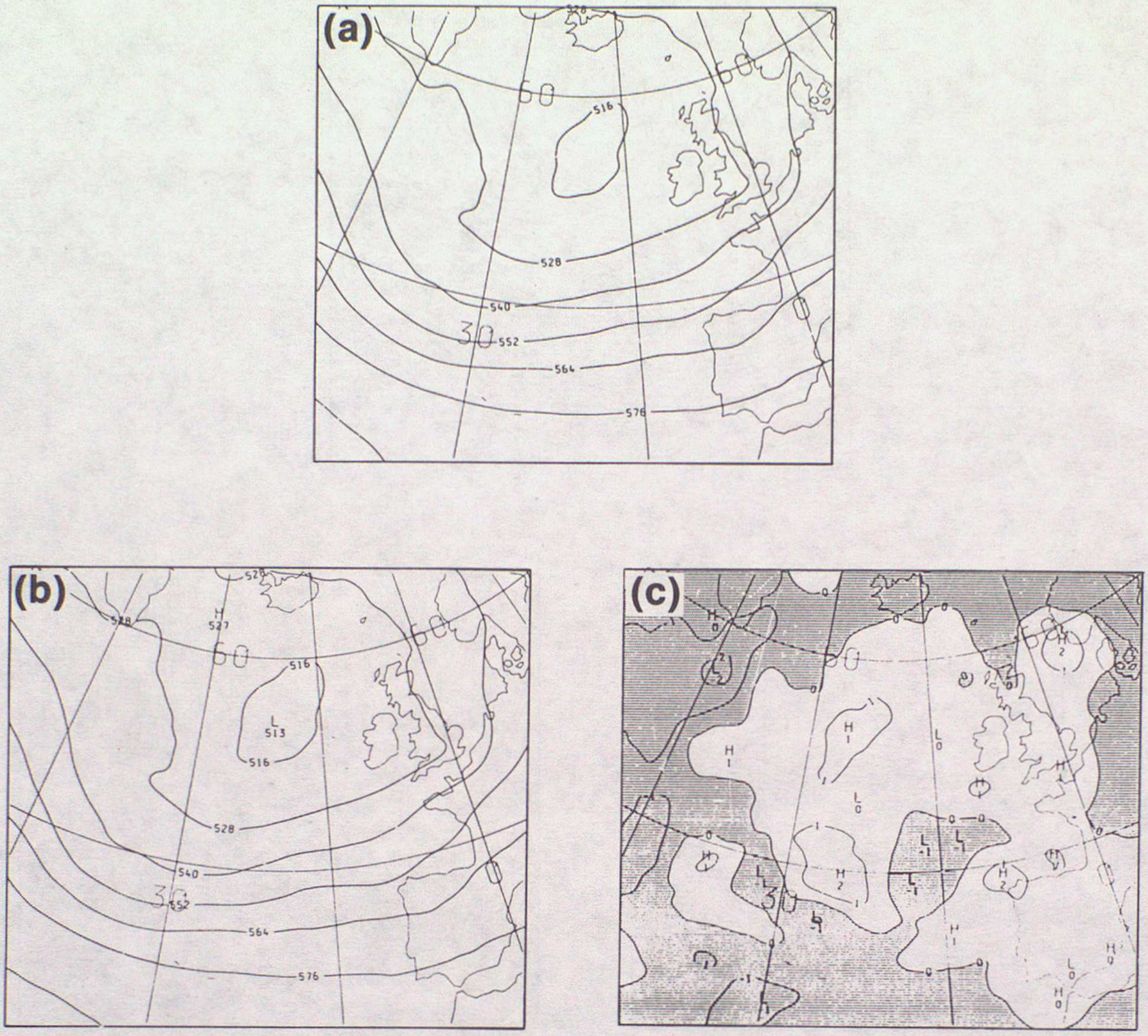

(a)
60
516
528
540
30
552
564
576
(b)
H
527
L
513
(c)

Figure 3.16 (a) Operational fine-mesh analysis of 500 mb height valid at 0000 GMT 15 October, (b) best rerun analysis from fine-mesh assimilation with extra observations and increased weight to observations (contour interval 12 dam) and (c) difference (a) minus (b), negative values shaded, contour interval 1 dam.

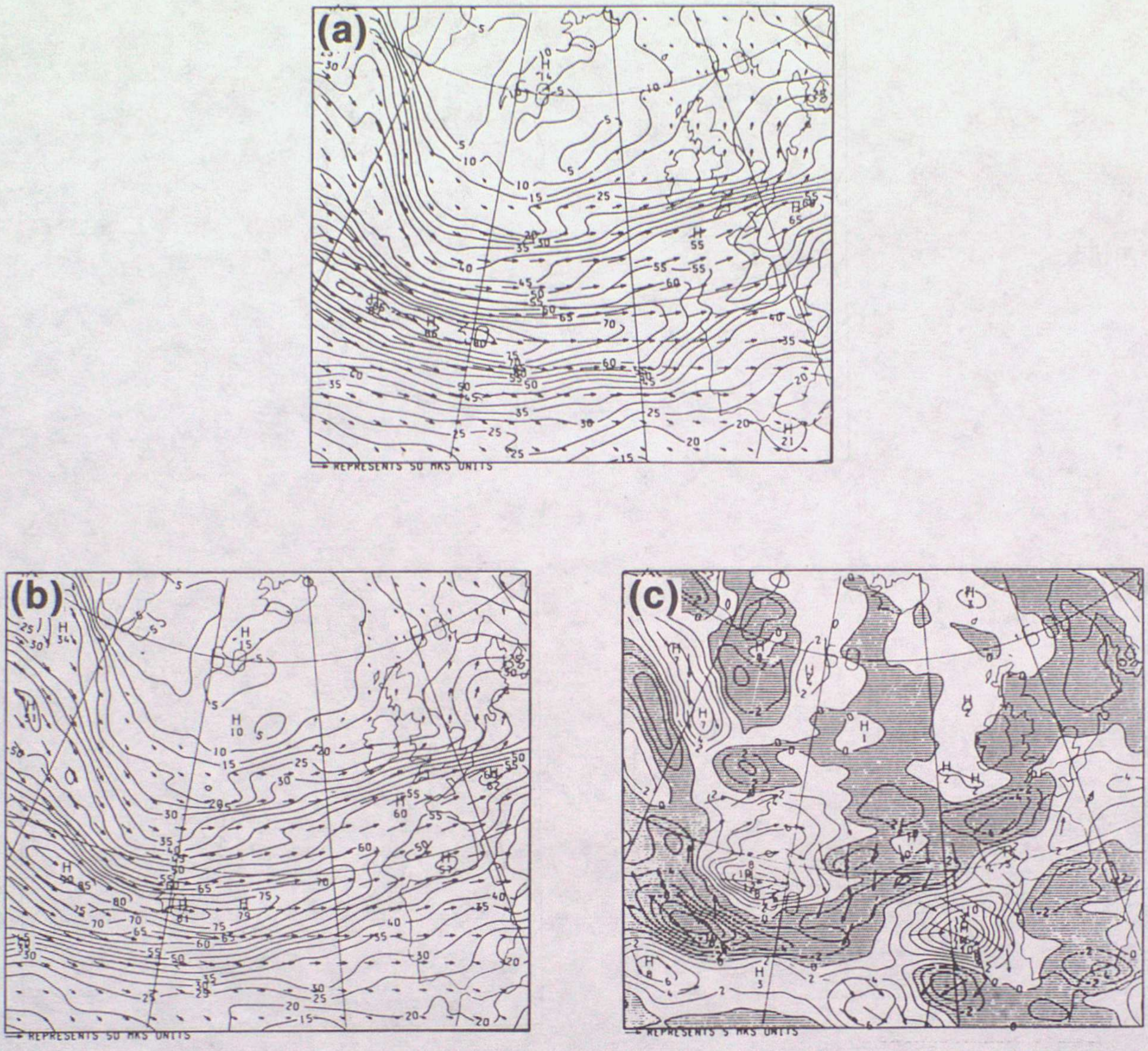

(a)
→ REPRESENTS 50 MKS UNITS
(b)
→ REPRESENTS 50 MKS UNITS
(c)
→ REPRESENTS 5 MKS UNITS

Figure 3.17 (a) Operational fine-mesh analysis of 250 mb winds valid at 0000 GMT 15 October, and (b) best rerun analysis from fine-mesh assimilation with extra observations and increased weight to observations. Wind speeds are shown as isotachs (contour interval 5 m s^{-1}), winds greater than 10 m s^{-1} are shown as arrows, with length proportional to speed. (c) Difference (a) minus (b): wind speed difference (contour interval 2 m s^{-1}, negative shaded), and vector wind differences greater than 5 m s^{-1} (arrows).

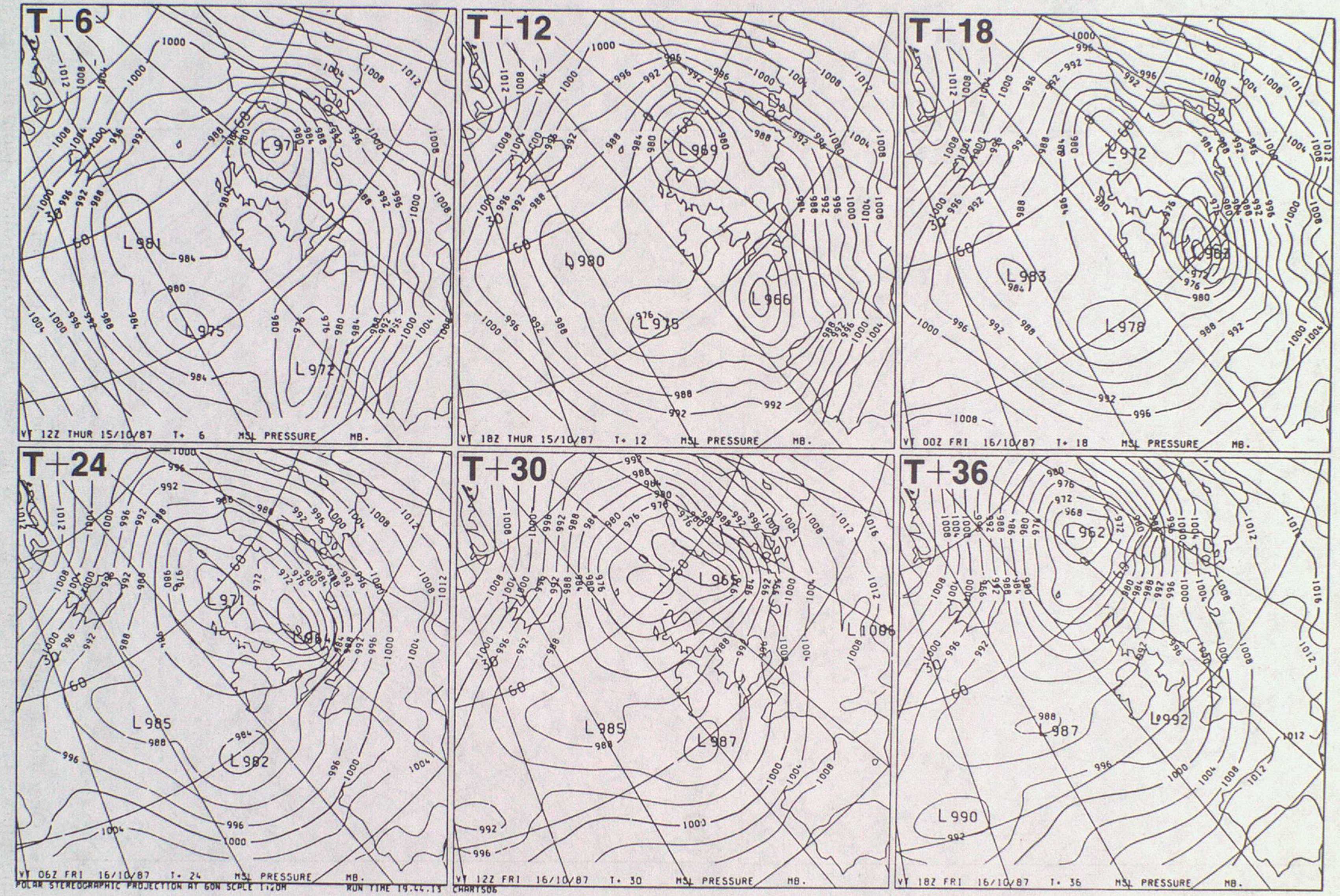

T+6
VT 12Z THUR 15/10/87 T+ 6 MSL PRESSURE MB.
L971
L981
L975
L972
T+12
VT 18Z THUR 15/10/87 T+ 12 MSL PRESSURE MB.
L969
L980
L966
L975
T+18
VT 00Z FRI 16/10/87 T+ 18 MSL PRESSURE MB.
L972
L962
L983
L978
T+24
VT 06Z FRI 16/10/87 T+ 24 MSL PRESSURE MB.
L971
L985
L982
T+30
VT 12Z FRI 16/10/87 T+ 30 MSL PRESSURE MB.
L965
L1006
L985
L987
T+36
VT 18Z FRI 16/10/87 T+ 36 MSL PRESSURE MB.
L962
L987
L992
L990
POLAR STEREOGRAPHIC PROJECTION AT 60N SCALE 1:20M
RUN TIME 19.44.13
CHARTS06

Figure 3.18 Sea-level pressure forecast from operational fine-mesh analysis for 0600 GMT 15 October. 6-hourly forecast fields starting at 1200 GMT 15 October, contour interval 4 mb.

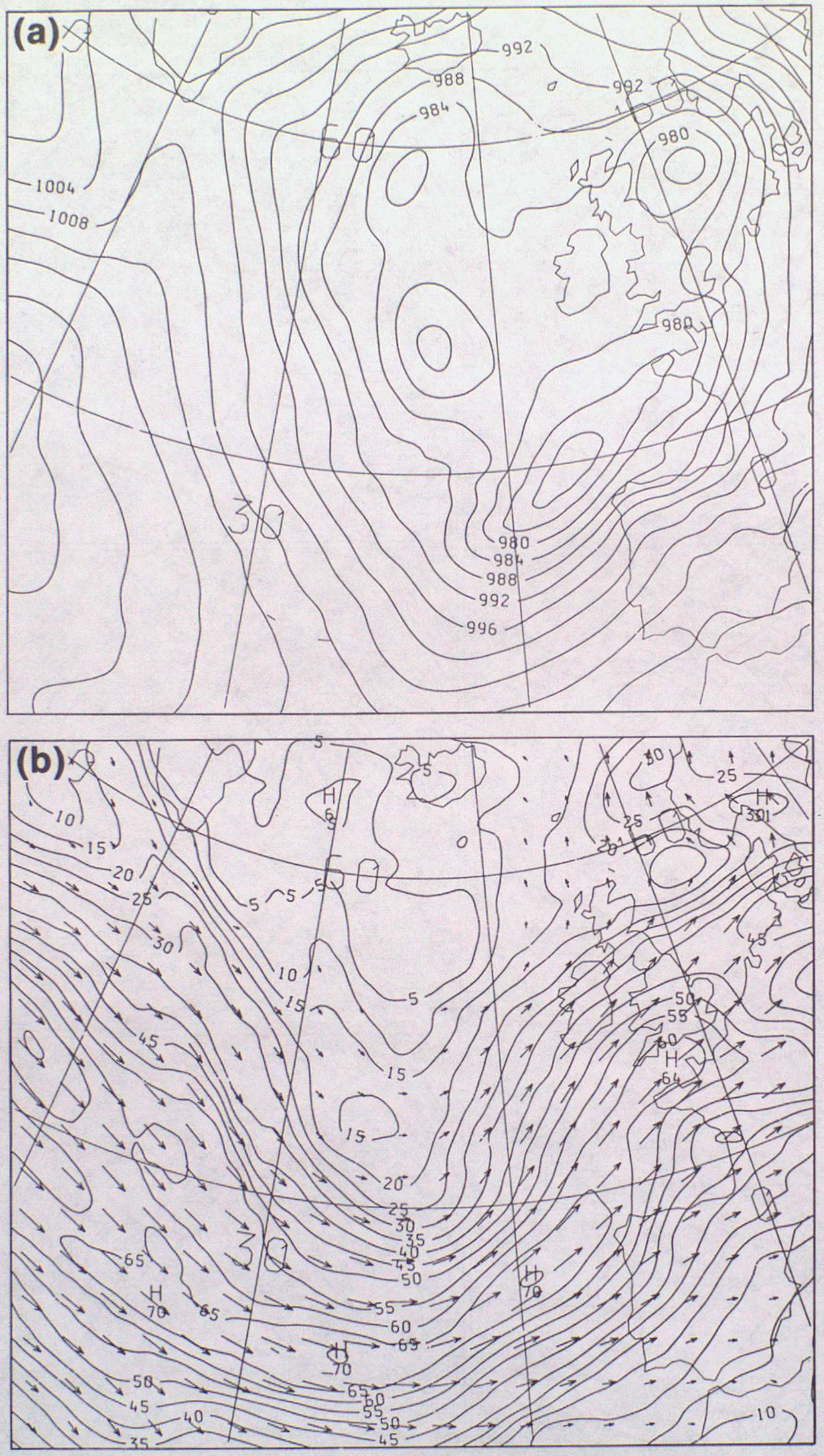
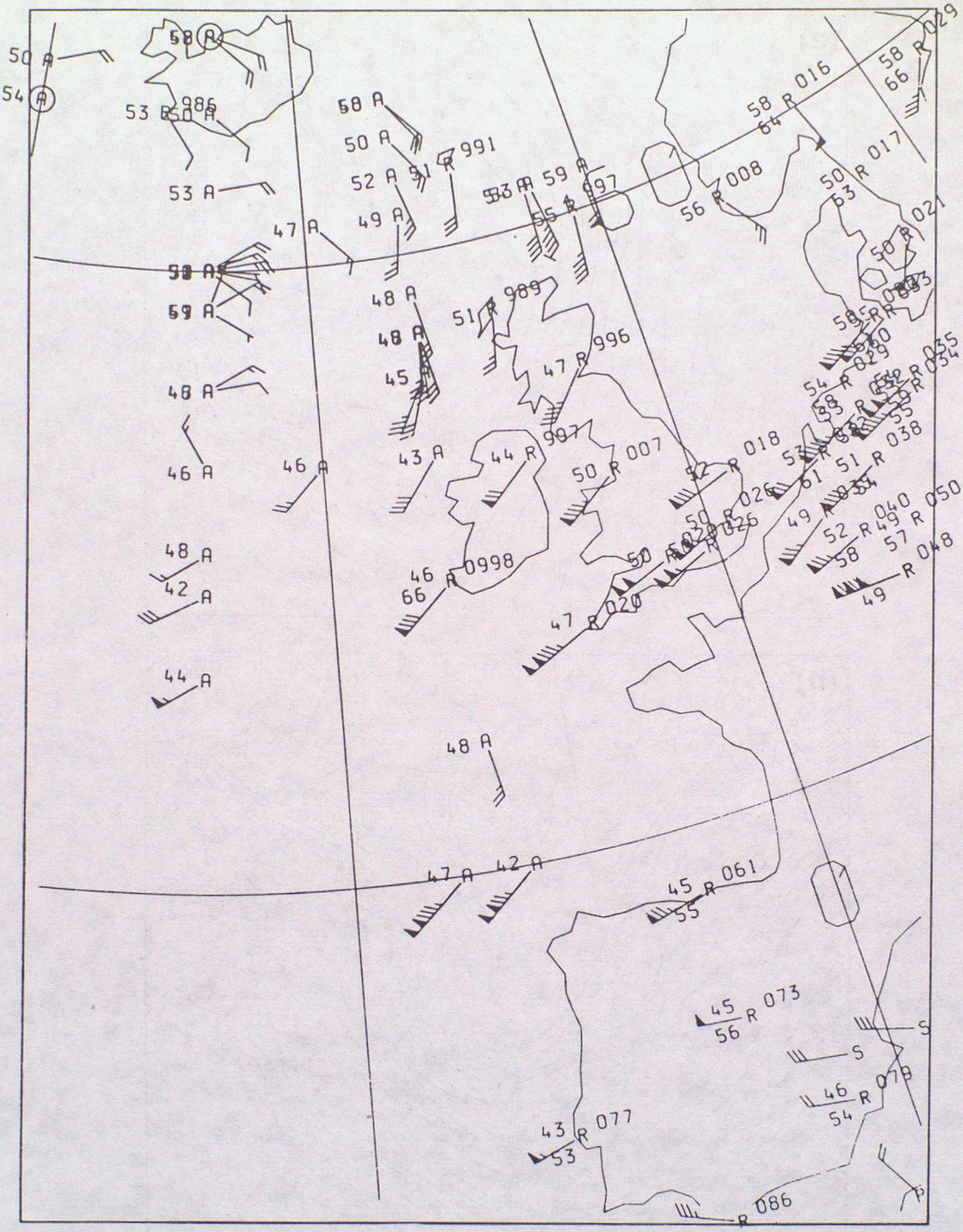

(a)
992
988
984
980
1004
1008
60
30
980
984
988
992
996
(b)
10
15
20
25
30
45
5
H
6
60
0
30
25
H
30
20
10
15
5
50
55
60
H
64
15
20
25
30
35
40
45
50
55
60
65
65
H
70
H
70
H
70
50
45
40
35
65
60
55
50
45
10

Figure 3.19 Operational fine-mesh analysis for 1200 GMT 15 October: (a) sea-level pressure (contour interval 4 mb) and (b) 250 mb wind. Wind speeds are shown as isotachs (contour interval 5 m s^{-1}), winds greater than 10 m s^{-1} are indicated by arrows, with length proportional to speed.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58 A
53 A
50 A
986
58 A
50 A
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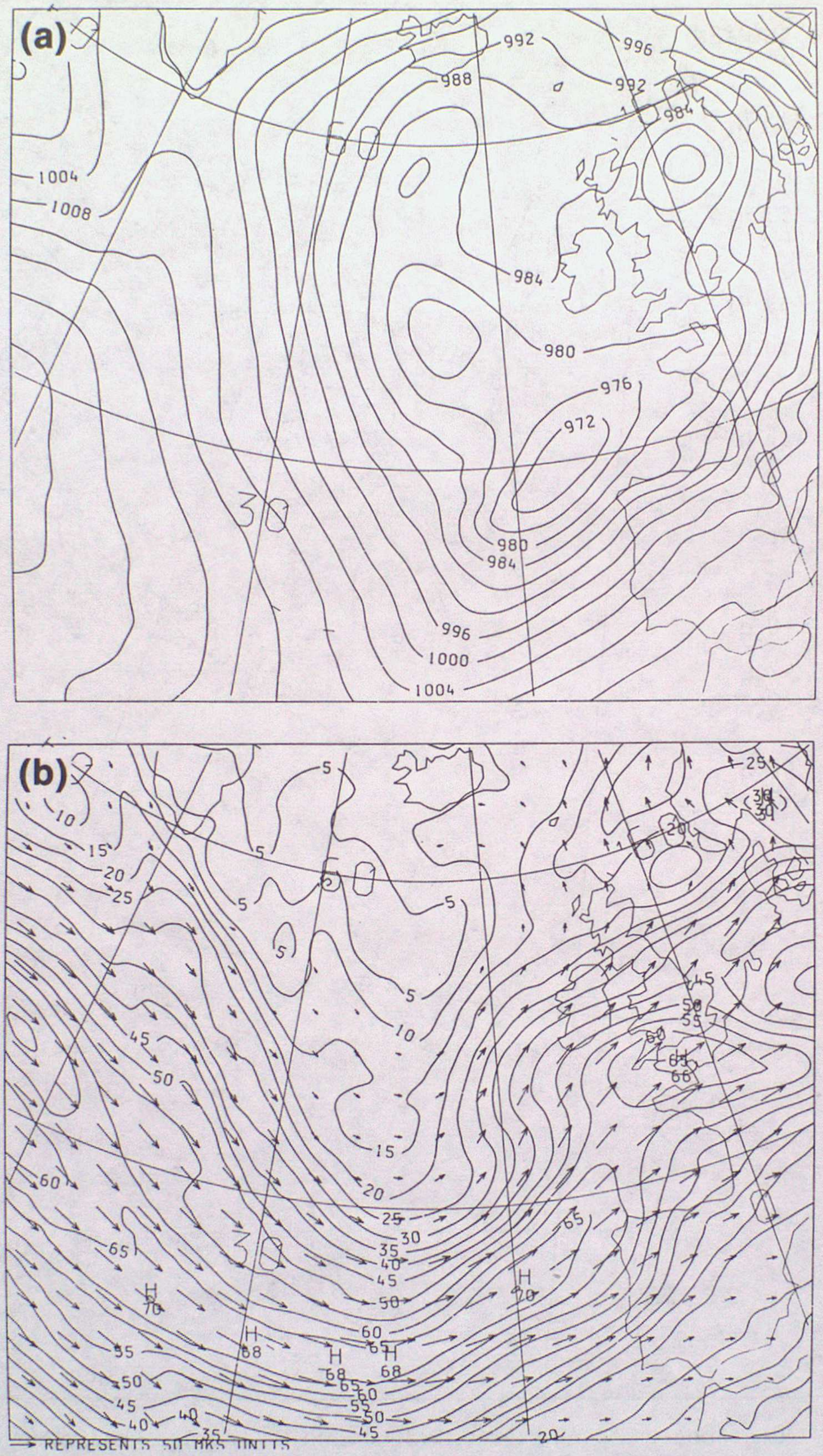
51 R 991
53 A
47 A
49 A
53 A 59 A
55 R 997
56 R 008
58 R 016
64
58 R 029
66
50 R 017
53
58 R 021
50 A
59 A
48 A
48 A
45
51 R 989
47 R 996
48 A
46 A
46 A
43 A
44 R 997
50 R 007
52 R 018
53
61
51 R 038
54
58 R 029
R 035
R 034
55
50 R 026
49 A
52 R 040
58
49
57 R 050
R 048
49
48 A
42 A
46 R 0998
66
47 R 020
44 A
48 A
47 A
42 A
45 R 061
55
45
56 R 073
S
S
46
54 R 079
43 R 077
53
R 086
P

Figure 3.20 Observations at 250 mb ±25 mb, for 1200 GMT 15 October ±3 hours. A small symbol at the observation position identifies the observation type: 34 radiosondes from land stations (R), 2 pilot-balloon soundings (P), 44 aircraft reports (A), and 25 cloud-motion winds were within the area shown. The aircraft report at 48° N, 10° W was rejected as incorrect.


(a)
992
996
988
992
984
1004
1008
984
980
976
972
980
984
996
1000
1004
(b)
10
15
20
25
5
5
5
5
5
10
45
50
15
20
25
30
35
40
45
50
60
65
H
70
H
68
H
68
H
68
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45
40
40
35
65
65
55
60
50
45
H
20
20
25
30
30
20
45
50
55
60
H
65
66
→ REPRESENTS 50 MKS UNITS

Figure 3.21 Test fine-mesh analysis for 1200 GMT 15 October: (a) sea-level pressure (contour interval 4 mb) and (b) 250 mb wind (isotach interval 5 m s^{-1} and winds greater than 10 m s^{-1} are indicated by arrows, with length proportional to the speed).

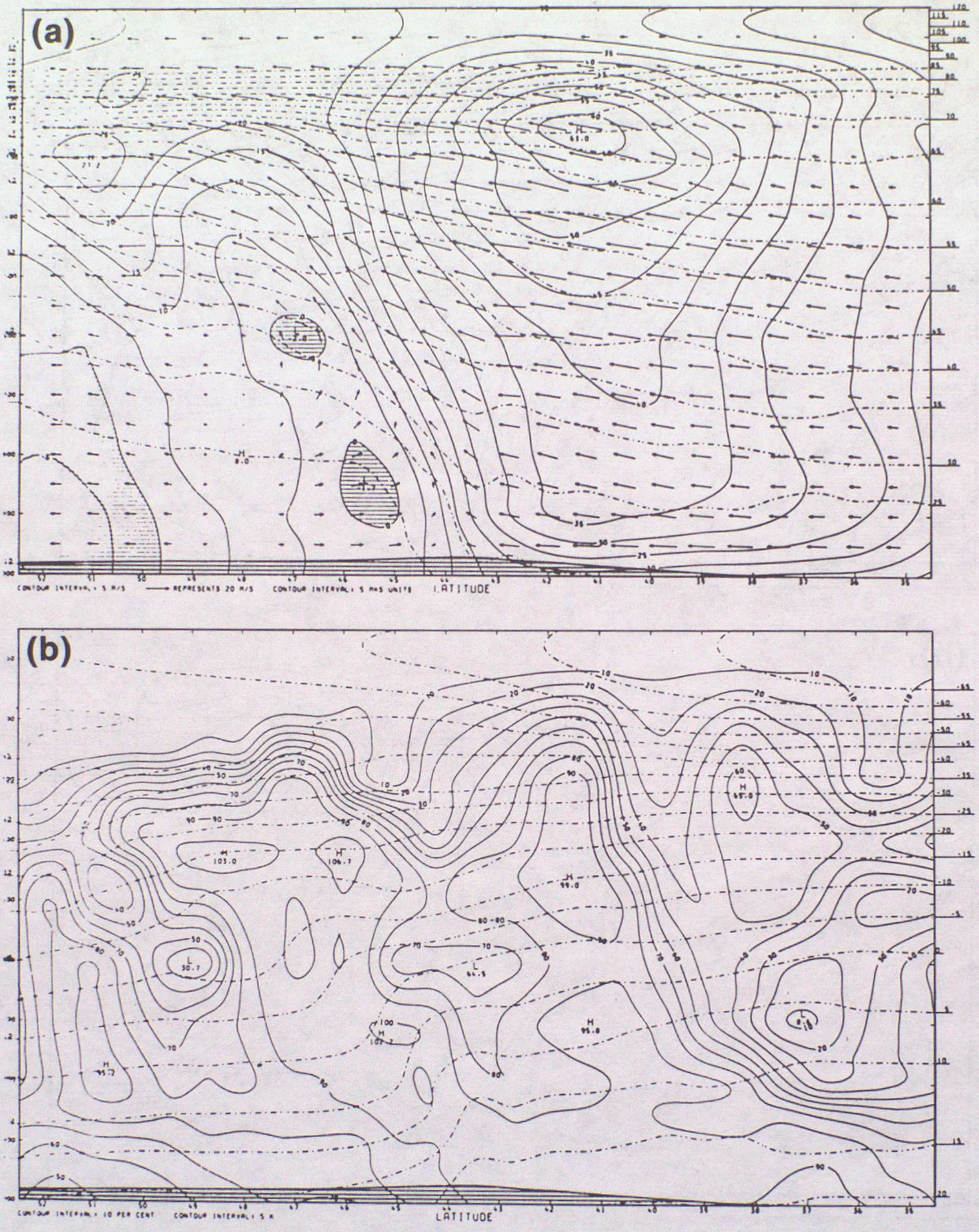


Figure 3.22 North–south cross-section along 14° W from the test fine-mesh analysis at 1200 GMT 15 October. (a) Winds: eastward component (solid lines, contour interval 5 m s^{-1}, negative winds shaded), northward component and upward component (arrows) and potential temperature (pecked lines, contour interval 5°C). (b) Relative humidity (solid lines, contour interval 10%) and temperature (pecked lines, contour interval 5°C).

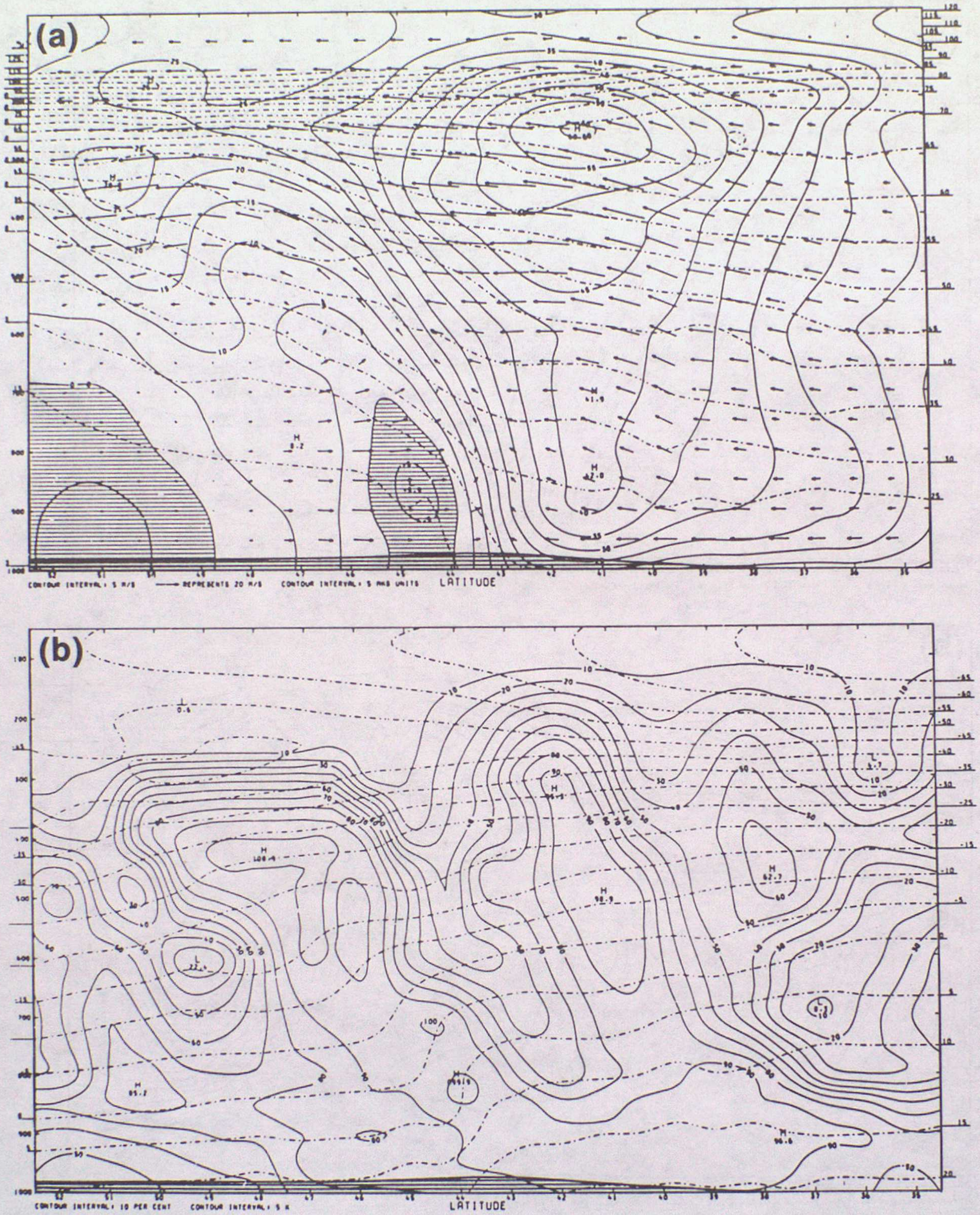


Figure 3.23 North–south cross-sections along 14° W from the operational fine-mesh analysis at 1200 GMT on 15 October. (a) Winds: eastward component (solid lines, contour interval 5 m s^{-1}, negative winds shaded), northward component and upward component (arrows), and potential temperature (pecked lines, contour interval 5°C). (b) Relative humidity (solid lines, contour interval 10%) and temperature (pecked lines, contour interval 5°C).

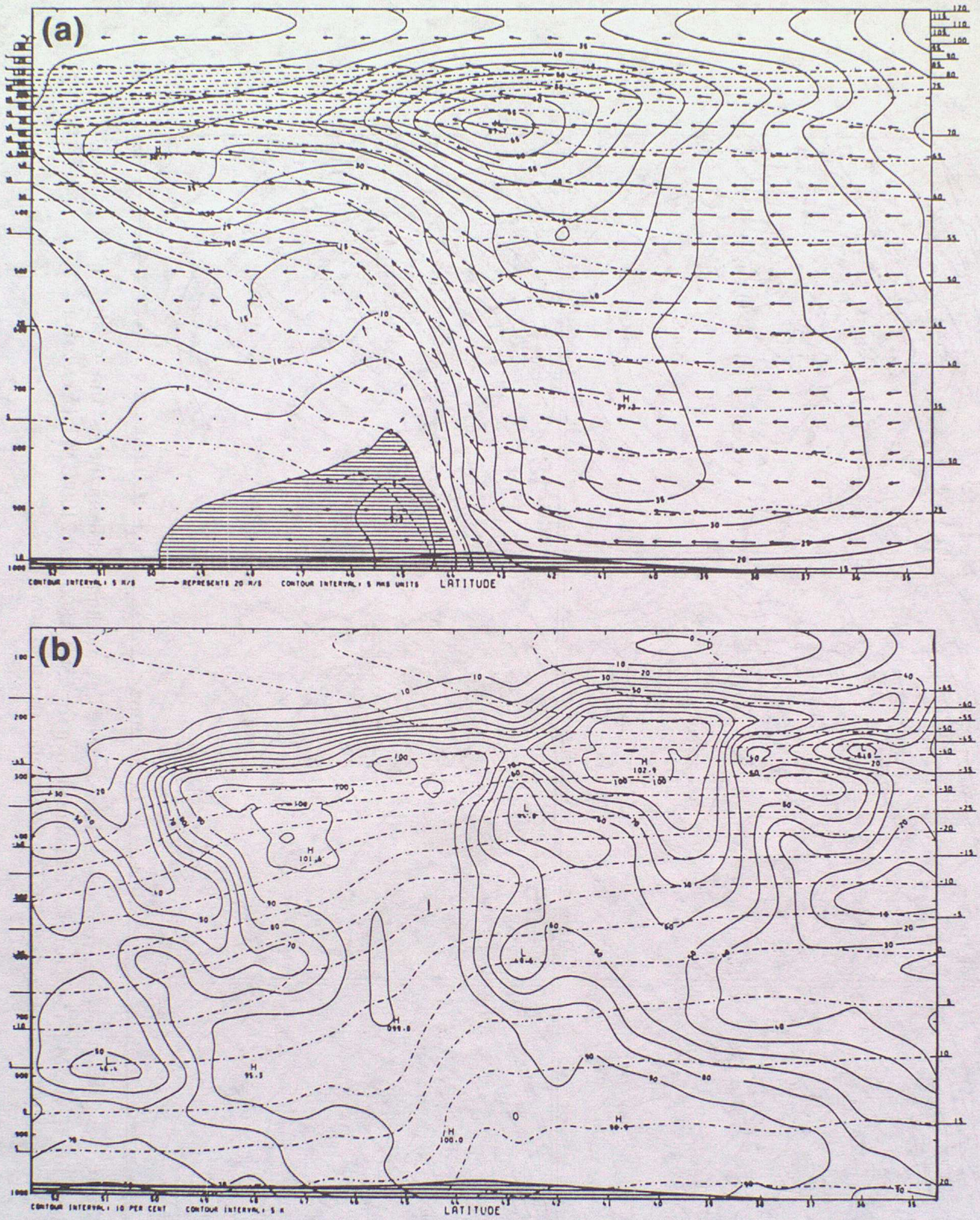


Figure 3.24 North–south cross-sections along 14° W from the 'best' fine-mesh forecast at 1200 GMT 15 October from a fine-mesh analysis at 0000 GMT. (a) Winds: eastward component (solid lines, contour interval 5 m s^{-1}, negative winds shaded), northward component and upward component (arrows), and potential temperature (pecked lines, contour interval 5°C). (b) Relative humidity (solid lines, contour interval 10%) and temperature (pecked lines, contour interval 5°C).

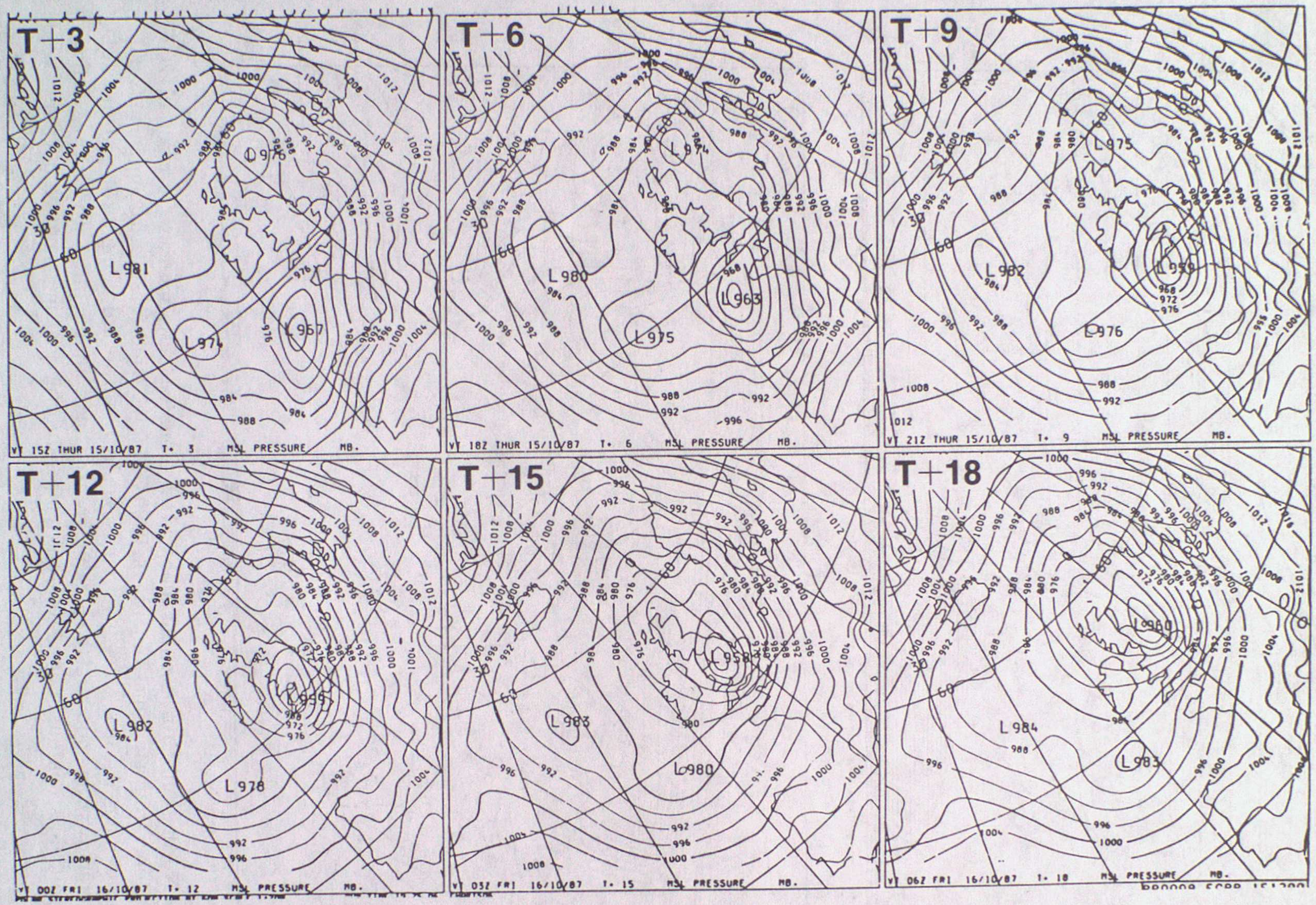

T+3
L981
L974
L967
L976
VT 15Z THUR 15/10/87 T+ 3 MSL PRESSURE MB.
T+6
L974
L980
L975
L963
VT 18Z THUR 15/10/87 T+ 6 MSL PRESSURE MB.
T+9
L975
L982
L959
L976
VT 21Z THUR 15/10/87 T+ 9 MSL PRESSURE MB.
T+12
L982
L955
L978
VT 00Z FRI 16/10/87 T+ 12 MSL PRESSURE MB.
T+15
L958
L983
L980
VT 03Z FRI 16/10/87 T+ 15 MSL PRESSURE MB.
T+18
L960
L984
L983
VT 06Z FRI 16/10/87 T+ 18 MSL PRESSURE MB.

Figure 3.25 Sea-level pressure from a forecast using the fine-mesh model from the test fine-mesh analysis for 1200 GMT 15 October. Fields are shown for 1500, 1800 and 2100 GMT 15 October (top row), and 0000, 0300 and 0600 GMT 16 October (bottom row).

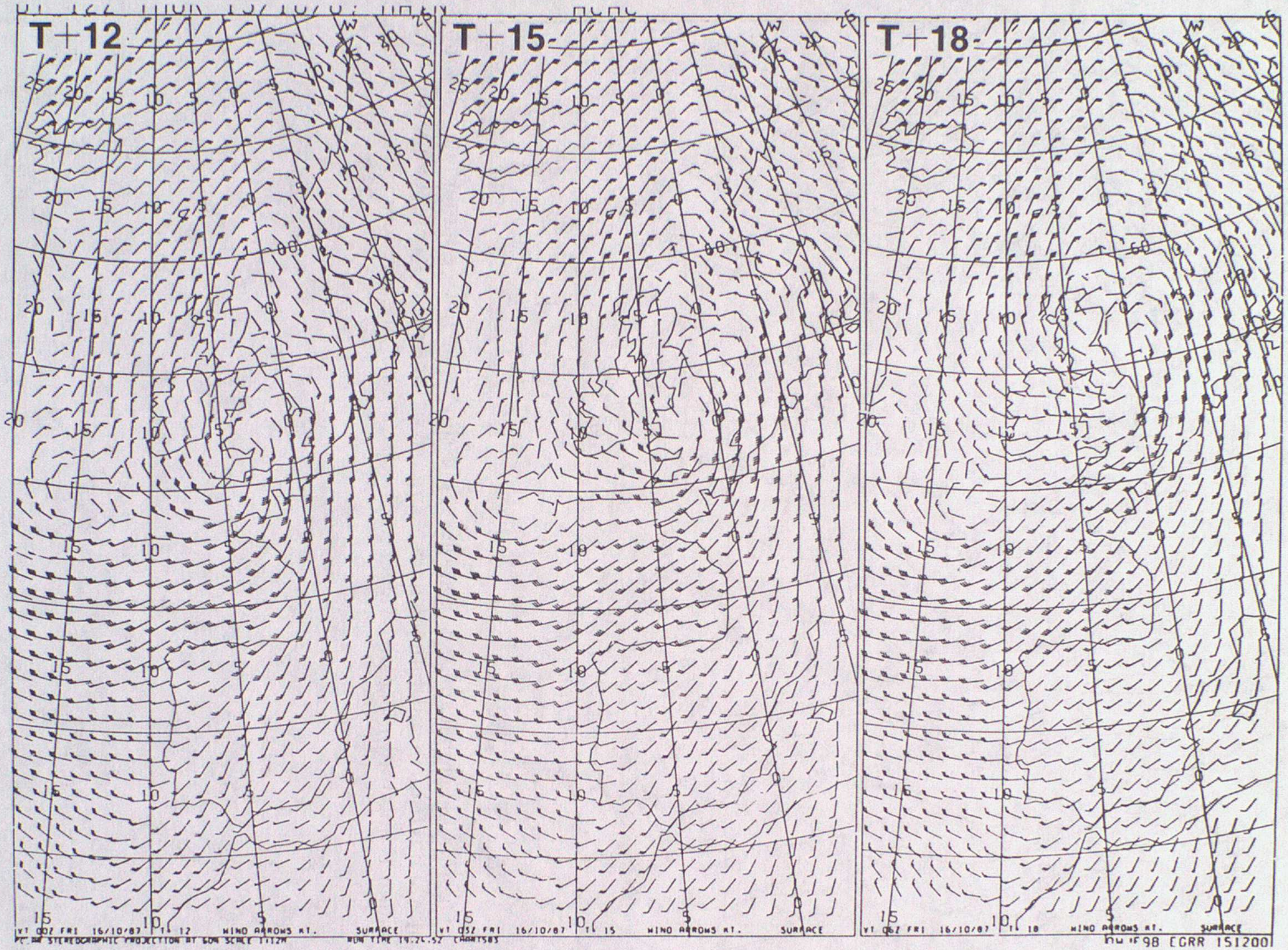

T+12
T+15
T+18
WIND ARROWS KT.
SURFACE

Figure 3.26 Surface wind forecasts from a forecast using the fine-mesh model from the test fine-mesh analysis for 1200 GMT 15 October. Fields are shown for 0000, 0300 and 0600 GMT 16 October. Each full barb represents 10 kn.

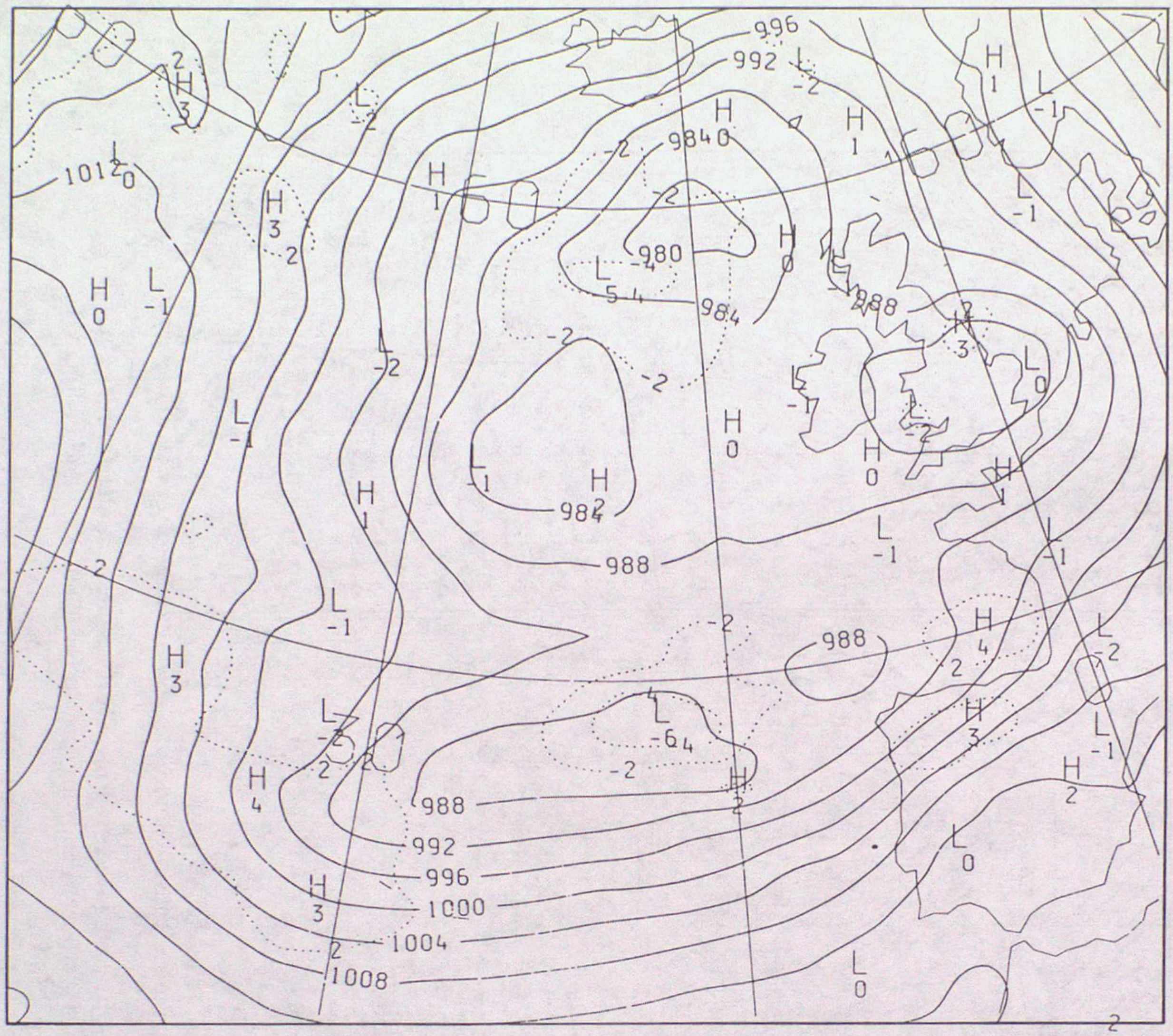


Figure 3.27 Operational global analysis of sea-level pressure (solid lines, contour interval 4 mb), and difference of this from the operational fine-mesh analysis (dotted lines, contour interval 2 mb, the zero contour is not drawn; negative values imply operational pressure lower).

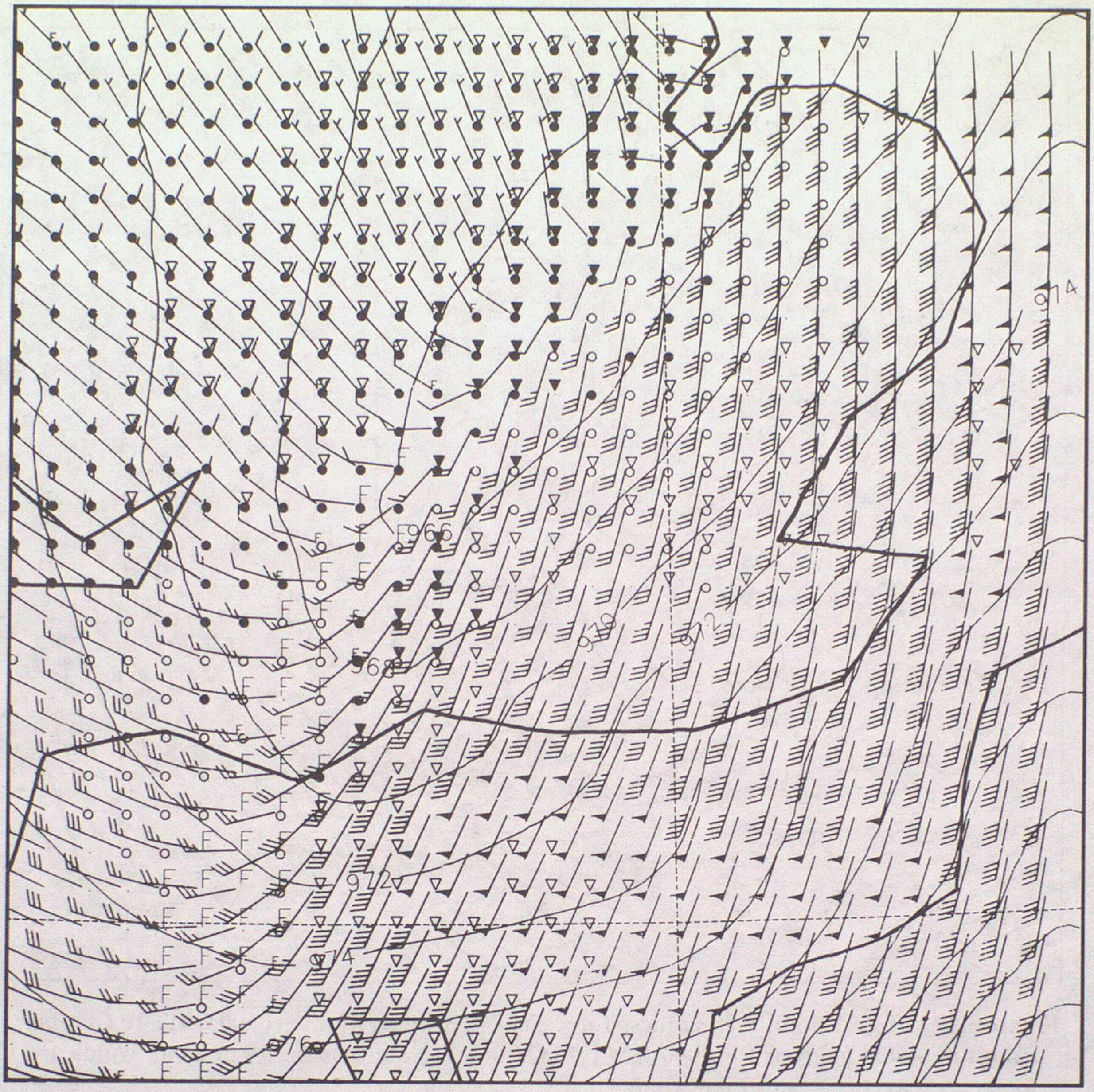


Figure 3.28 12-hour mesoscale model forecast of pressure, wind and weather over south-eastern Britain from data time 1200 GMT 15 October. Isobars are marked at 2 mb intervals, winds in knots, and weather by circles indicating precipitation from layer cloud (greater than 0.5 mm h^{-1} if solid) and triangles indicating showers (greater than 0.5 mm h^{-1} if solid). F indicates very low cloud.

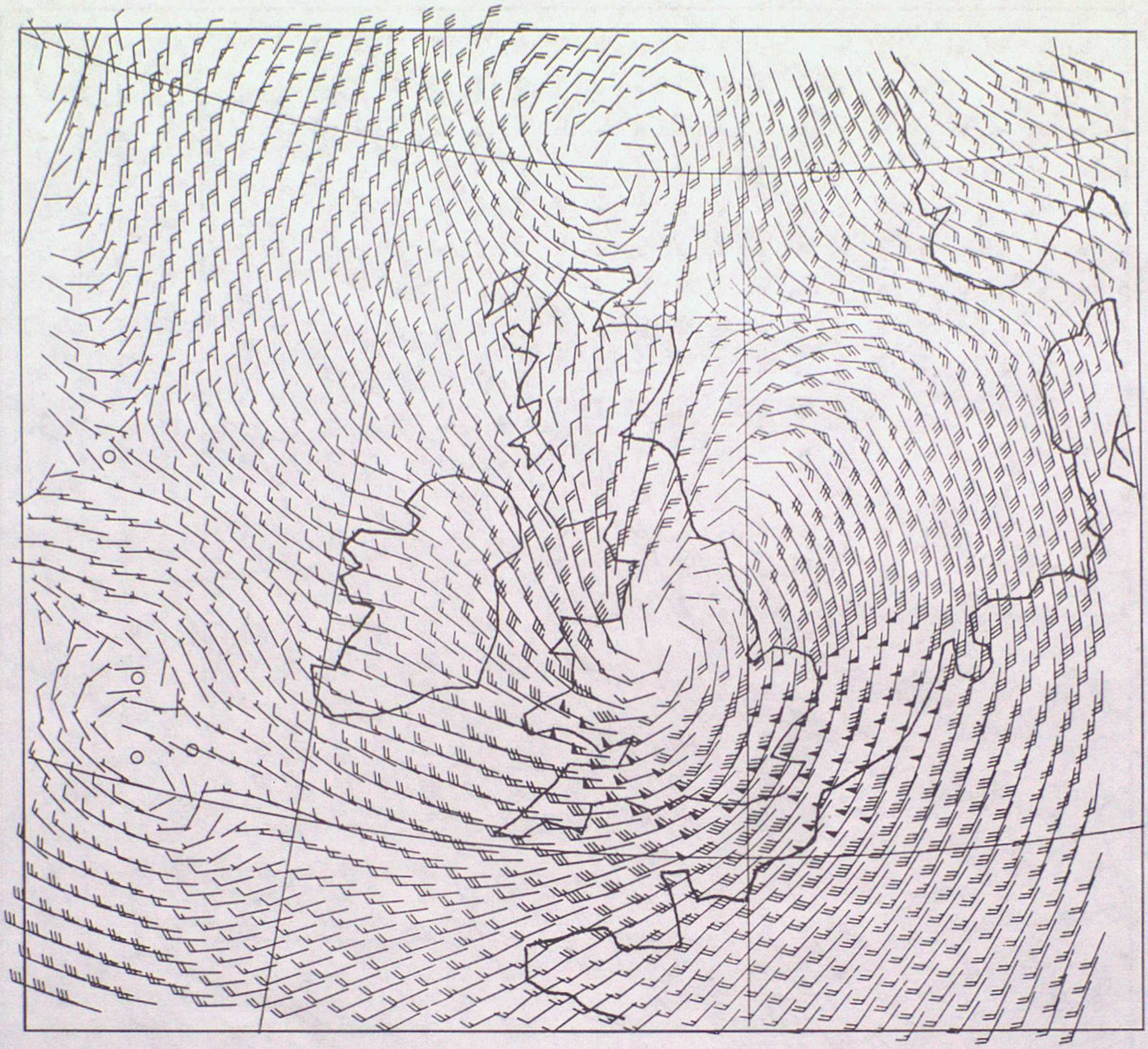


Figure 3.29 High-resolution fine-mesh forecast of 10 m mean winds at 0600 GMT 16 October, run from the global analysis for 0000 GMT 15 October. (Note that the 10 m mean winds are 15% weaker, on average, than 25 m winds.)

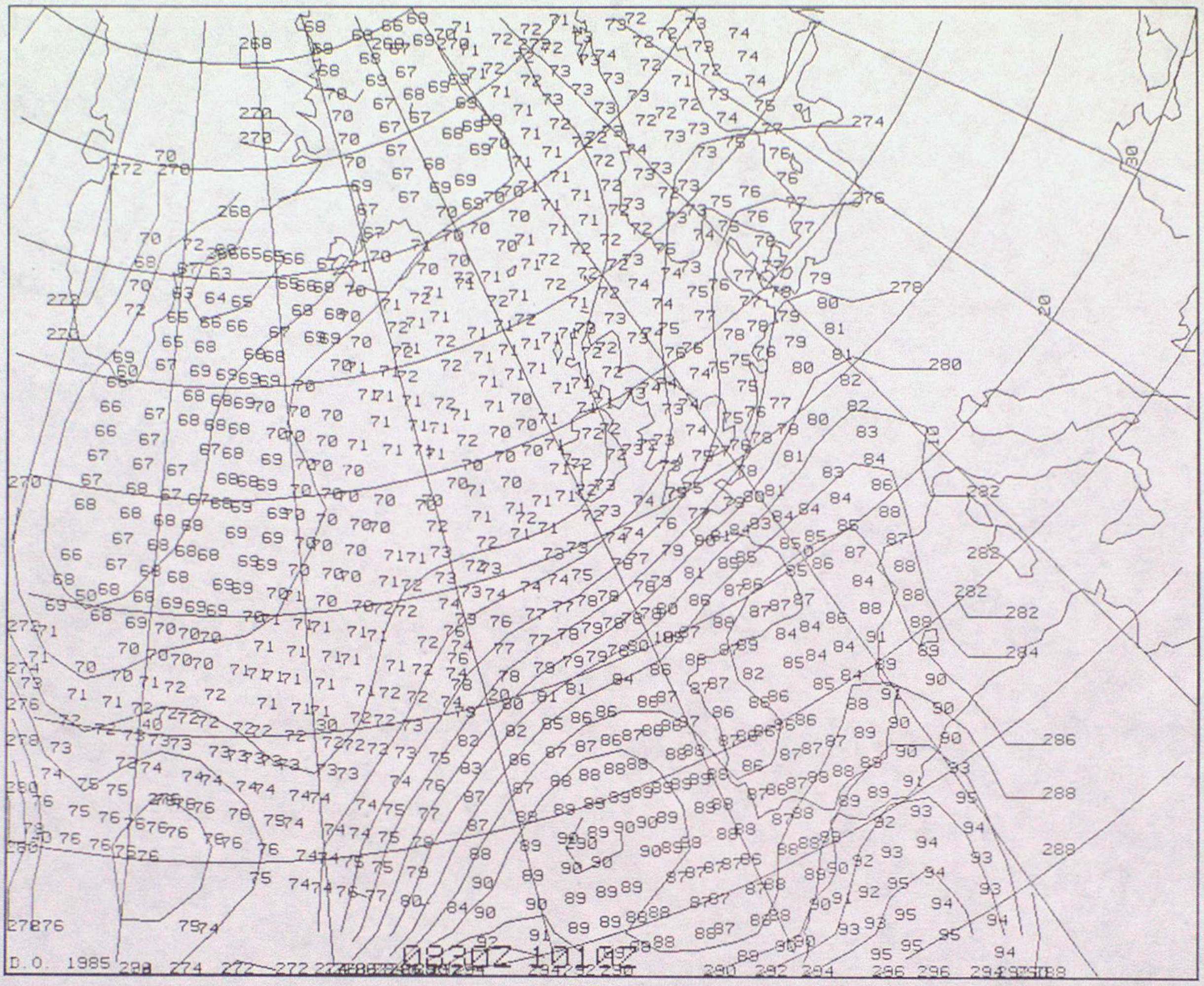

D.O. 1985
0830Z 1010Z
268
270
272
274
276
278
280
282
284
286
288
290
292
294
296
20
30

Figure 3.30 Observations from the local area sounding system (LASS), from direct read-out of radiances from the TIROS satellite operational vertical sounder. Retrieved 850 mb temperatures from 2 orbits, at 0830 GMT and 1010 GMT on the 15 October, are plotted in K, omitting the leading 2. Contours at intervals of 2 K have been drawn to fit the data.

Chapter 4

PUBLIC FORECASTS AND WARNINGS

4.1 Medium-range (2 to 6 day) forecasts

Useful forecast guidance for the 15/16 October began with the forecasts issued on Sunday 11 October.

The BBC 1 television programme 'Weather for Farmers' at 1258 on Sunday 11 October mentioned a spell of 'rather wet and windy weather right at the end of the week' (Annex 4.1). The caption map displayed at the end of the broadcast included 'becoming very windy late in the week' (Annex 4.2). Many of the BBC television and radio forecasts from Monday to Wednesday highlighted the stormy weather expected later in the week (Annexes 4.3 and 4.4). On the BBC 1 Wednesday broadcast at lunch-time for example, instead of opening with today's weather as is usual, the weatherman spoke of a low pressure system which 'is going to deepen like mad and head up and give us an angry spell of weather, wet and windy' on Thursday and Friday.

An example of the service that was provided to specialist users is shown at Annex 4.5, which contains the weather forecasts issued during the week to the Automobile Association. On Monday, the forecast for Thursday for south-east England was '... becoming windy, gales in places'. On Tuesday, the summary spoke of 'a major storm, crossing Britain from the south-west during Thursday and Friday'. The forecast for south-east England for Thursday was '.... becoming very windy with gales or storm-force winds developing'. For Friday, the forecast was 'stormy at first, then slowly becoming less windy'.

Finally, the Meteorological Office issues forecasts for three to five days ahead on a pre-recorded telephone service, Weathercall. Transcripts are at Annex 4.6; the relevant issues from Monday to Wednesday all referred to the expected strength of the wind.

4.2 Media forecasts issued on Thursday 15 October

For the reasons described in chapters 2 and 3, on the day before the storm the Central Forecasting Office did not anticipate the full severity of the winds. The forecasts highlighted the deep depression moving up from the south-west but concentrated on the heavy rain which was expected as a result. This was reflected in the wording used in the public forecasts issued that day. Part of the reason for the emphasis on rain lay in the weather of the previous week. There had already been copious amounts of rainfall during October, and over the previous several days there had been widespread flooding, especially in the south and east. This concern was clearly dominant in the forecaster's minds — for example, a message from Norwich Weather Centre to London Weather Centre on the afternoon of the 15th expressing the water authorities' serious concern at the risk of widespread flooding should the rain expected that night in their area occur (see Annex 4.7).

The BBC 1 television weather forecasts at 1325, 1833 and 2128 (Annex 4.8) all mentioned the likely wind in the south and east, but gave it less emphasis than the rain. Nevertheless the wind symbols on the charts for both the early evening and mid-evening broadcasts (symbol charts identical) showed winds of 50 m.p.h., that is 43 kn, for 'tonight' off the east coast and in the eastern English Channel (see Annex 4.8(b)). Note that the symbols represent mean wind speeds, not gusts.

The early evening broadcasts on BBC East and BBC South, performed by staff from Norwich and Southampton Weather Centres (Annex 4.9), emphasized the wind rather more than the national forecast had done — as one would expect from a local forecast covering an area with extensive coast lines — but the national and local basic products were entirely consistent with each other.

On BBC Radio 4, the 1755 broadcast spoke in the introduction of 'an intense low pressure centre' moving across the midlands overnight bringing 'strong winds'. The main body of the forecast for south-east England referred to expected conditions as 'quite windy with southerly winds touching gale force near south-eastern coasts for a while'.

The local radio scripts written at London, Southampton and Norwich Weather Centres and those scripts written for the 24-hour forecast service on Weathercall for the affected areas dealt with the situation in a similar way, tending to emphasize the unsettled nature of the weather and the rain and making less of the wind. This was particularly the case with the forecasts for inland areas as opposed to those for coastal areas. A representative selection of scripts is shown at Annex 4.10.

By midnight, however, rather more was being made of the expected winds. The live 0020 Radio 4 broadcast (Annex 4.11) emphasized the severe weather to occur that night; part of it said 'just to re-emphasize, some dirty, wet weather to come, especially for England and Wales, as a really nasty depression sweeps up from Biscay, ... so some really unpleasant conditions if you are out and about on the roads and motorways tonight, some torrential rain, stormy winds eventually, especially on the Channel coast, and there will be inland gales as well'.

Finally, two television broadcasts are relevant in considering the wider area affected by the strong winds. In the BBC 2 'Weatherview' programme (pre-recorded at 2030, as usual, for broadcast at 2305), much was made of the strong winds over the sea areas and the near continent (see Annex 4.12). Earlier in the day, the 1355 broadcast for the European satellite television Superchannel, which is presented by the weatherman at the BBC Television Centre, had opened with 'It's a case of batten down the hatches I think for some parts of Europe; some very, very stormy weather on the way indeed'. There was a subsequent reference to likely gales in France and the Low Countries and, later, in Scandanavia.

4.3 Warnings

Before going into details about the warnings issued to various authorities, it is necessary to describe the arrangements by which such warnings are given. The Meteorological Office, through its Weather Centres, gives notification of conditions expected to exceed given thresholds to those authorities requesting them. The thresholds are defined by the customer according to their operational needs.

Of particular relevance on this occasion are the arrangements by which the Meteorological Office warns emergency authorities. The London Fire Brigade has arranged to receive warnings if winds are expected to be more than 30 m.p.h.; this is because winds of this strength curtail their use of long ladders. The London Fire Brigade has not asked to be warned of any other hazardous weather conditions, or of any wind strengths greater than the 30 m.p.h. threshold. No other Fire Brigade has asked for warnings of any nature to be given and there are no national arrangements.

There is a national arrangement for warning Police Forces of fog on motorways, but all other arrangements for issuing warnings to the Police are organized on a local basis. In the south-east, the local Police Forces receive warnings of snow, icy roads and heavy rain as well as fog, but there are no arrangements for the issue of strong wind warnings. In East Anglia, however, Police Forces do receive warnings of mean winds greater than 30 kn. Medical authorities only receive warnings by request and arrangement; in the south-east of England there are no such arrangements.

The Meteorological Office has organized a FLASH weather service (Annex 4.13) by which the public can be warned via radio and television of the occurrence of severe weather which may cause considerable inconvenience to a large number of people and/or present a danger to life. These warnings are only issued when there is a virtual certainty (usually based on actual weather observations) and the aim is to give immediate warnings of the onset of severe weather. The FLASH message system is important during the day when avoiding action, particularly by those intending to travel, can be taken. It is clearly much less effective at night when most are in bed asleep, but they are not then exposed to weather hazards to the same extent. Weather FLASH messages are still issued however.

FLASH warnings may be issued in cases of dense fog, heavy rain, heavy snow, widespread icy roads and severe inland gales and blizzards. They cover the 18 major urban areas of the United Kingdom (with the exception of blizzards which can refer to any area). Arrangements have been made for warnings to be broadcast through the BBC on national radio and television and, on those independent television and radio companies which agree to carry them.

Apart from receiving copies of FLASH warnings, the BBC Motoring Unit receives warnings of hazardous weather for broadcast on the BBC radio network. The criteria for these messages are less severe than for the FLASH messages; in the case of strong winds, the threshold is a mean speed of greater than 30 kn.

Warnings of exceptionally severe weather, which may call for military aid to be provided to the civil community, are issued to the Ministry of Defence at any time throughout the 24 hours. Forecasts are required when the following phenomena are anticipated:

(a) Severe inland gales with mean wind speed of 50 m.p.h. (43 kn) or more; 'inland' means anywhere over inhabited parts of the United Kingdom.
(b) Heavy and prolonged rain.
(c) Snowfall likely to reach a level depth of one foot or more.

The Meteorological Office also issues warnings of high winds to British Rail because of problems in windy conditions with overhead lines. The requested threshold is a mean speed of 34 kn (i.e. gale force) or gusts over 60 kn. Warnings are only provided to those parts of the British Rail network where there are overhead lines; Southern Region is not covered.

On this occasion, the relevant warnings were issued at the following times.

	Recipient	Time (GMT) 15/16 October
1.	British Rail (Eastern Region)	1730
2.	London Fire Brigade	2150
3.	East Anglian Police Forces	2305
4.	BBC Motoring Unit	2315
5.	FLASH Message of severe gales	0120
6.	MOD for and to civil community	0135
7.	London Fire Brigade	0140
8.	All Police Forces in south-east	0145

The text of all warnings is at Annex 4.14. Note that the warning to the London Fire Brigade at 0140 was on the initiative of the London Weather Centre forecasters — there is no arrangement for this. Similarly the warning to the police in the south-east was beyond any agreement in respect of strong winds.

4.4 Forecasts for sea areas

As early as 0630 GMT on 15 October, gale warnings were already in operation for all parts of the English Channel. At 1030 GMT on the same day warnings of severe gale for 9 'soon' were issued for the whole Channel except for sea area Plymouth ('soon' implies a time of validity between 6 and 12 hours after time of issue of the warning). These warnings were reaffirmed at 1710 GMT, except that it was anticipated that the gales in Portland would decrease to force 8 during the night.

The forecasts for the Channel sea areas were not revised until 2235 GMT on the 15th when warnings of storm force 10 were issued for all areas. These warnings were issued following an assessment of the 1800 GMT mean-sea-level pressure analysis. At 0135 GMT on the 16th the forecasts were increased to violent storm force 11 'imminent' (i.e. within 6 hours) for all parts of the Channel. A copy of all these warnings is at Annex 4.15.

In addition, some forecasts for inshore waters are prepared for broadcast by local radio stations. An example is included at Annex 4.16. The forecast for the inshore area from the Pool of London to North Foreland to Dungeness, issued to Radio Essex at 1631 on the 15th covering the period 1800 to 0600 on the 16th, was for winds increasing to between force 7 and severe gale 9 (30 to 45 kn) with gusts over 50 kn likely.

London Weather Centre issues many routine forecasts to the offshore industry operating in the North Sea. At Annex 4.17 is a series of forecasts for a location off the coast of Norfolk issued between Monday, 12 October and 0130 16 October. Apart from the high quality of the forecast early in the period, of particular relevance is the forecast issued on the afternoon of the 15th predicting winds overnight of 40 to 50 kn with gusts to 60 kn.

Generally the forecasts issued during 15 October for coastal or offshore areas, where wind is of course an important feature at all times, did include very strong winds. In particular, one major offshore contract actually began at midnight on the night of 15th/16th! Warnings issued were much appreciated by the operational staff offshore and proved to be very accurate.

4.5 Forecasts for civil aviation

The Senior Forecaster at London (Heathrow) Airport is responsible for the forecasts for civil aviation but there are regular discussions with the Senior Forecaster in the Central Forecasting Office. A strong wind warning was issued to 35 airfields in south-east England at 1328 GMT on the 15th valid up to midnight, forecasting wind speeds of 15 to 20 kn and gusts of 35 to 40 kn. A second strong wind warning was issued at 2300 GMT, followed at 0100 GMT on the 16th by a gale warning for winds speeds of 30 kn and gusts to 50 kn. This was quickly superseded by a storm warning issued at 0130 GMT forecasting a wind speed of 35 to 40 kn and gusts of 55 to 65 kn. At 0450 GMT a further storm warning was issued giving wind speeds of 35 to 40 kn and gusts to 80 kn. Subsequent warnings were for gale and strong wind (depending on location) gradually moderating.

The warnings proved sufficient for most operational purposes and although some damage is known to have occurred, no complaints have been received about the service provided.

4.6 Forecasts for military airfields

The Principal Forecasting Office (PFO) at Headquarters Strike Command is responsible for the forecasts issued for military airfields. The PFO produces its own forecast charts and for 0600 GMT 16 October it forecast a depression of 959 mb near 55° N, 0° W, little different from the 0600 GMT forecast produced earlier by the Central Forecasting Office at Bracknell.

Strong wind warnings were subsequently issued for military airfields south-east of the line Lincolnshire–Cornwall. Warnings of severe gales were issued during the evening, which preceded the onset of the gale at 6 stations by 3 hours or more, and at a further 5 stations by 8 hours. These warnings enabled the military authorities to take appropriate action and, apart from one aircraft parked inside a hangar which suffered superficial damage from a falling glass roof panel, no damage to aircraft has been notified.

4.7 Forecasts from other countries

A number of forecasts issued by the French National Weather Service have been obtained. It should be noted that forecasts are NOT issued covering the United Kingdom. For northern France, where very strong winds had always seemed likely (see for example Annexes 4.12 and 4.18), good warning was given. On the 14th, a message of severe weather was issued to various addresses, including the French railways, the Water Board, the Electricity Board, the national press and TV stations. The message forecast winds of 43–54 kn for Thursday over some coastal areas and the English Channel, with extreme gusts of 80 kn. This message is at Annex 4.19. Sea-area forecasts and gale warnings issued by the French National Weather Service are at Annex 4.20. These are generally similar to those issued by the Central Forecasting Office in Bracknell.

4.8 Summary and discussion

The medium-range forecasts issued (from the Sunday to the Wednesday) were generally very good though there is always uncertainty at this stage about the track of a depression and its intensity. Within 24 hours the expectation is to produce a much more detailed forecast. On this occasion there was mention of strong winds in most of the forecasts, but the extreme severity of the wind was not anticipated until late on Thursday evening.

Nearly all the users of the specialized forecasts produced by the Meteorological Office were satisfied with the service provided; some, in the offshore industry for example, were very grateful. It should be noted, however, that actions are geared to wind speeds which are not as extreme as those that occurred (for example, a gale force wind of 34 kn or greater). Further, when the notice of a very severe event is given, such action as can be taken in the circumstances may often be carried out at relatively short notice and there are staff available throughout the 24 hours. The general public is not in this position and while the short period FLASH weather warning system is effective by day, it is inevitably less so at night (although messages are still issued). Further ahead, warnings to the public may be put out via the standard radio and television presentations (both national and local). On national BBC television there have been increases (in recent years) in both the number of broadcasts and the time allotted. Nevertheless there may be scope for further action here.

One area where there will be changes of procedure concerns the warnings provided to the emergency authorities. The warnings required by the Ministry of Defence, in cases which may call for military aid to be provided to the civil community, are well defined. These go to a single point in the Ministry of Defence and work well, even though warning of exceptional conditions is usually only given with a few hours notice. A similar arrangement with police and other emergency authorities may prove to be necessary. This will be discussed, at the initiative of the Meteorological Office, with the bodies concerned. At the same time it would be useful to review the wider requirements of the emergency services for weather information. Current procedures, with the police for example, have developed over many years, mainly on a local basis. One exception to this is the arrangement for issuing warnings of dense fog to the police; this was set up in 1965 by the then Minister of Transport following a series of crashes on motorways in foggy conditions. Although on 15/16 October warnings were passed to emergency authorities in accordance with arrangements made (in some cases exceeding the agreed requirements), extension of this nationally organized scheme may well be needed. Information would still be provided on a regional basis by the Weather Centre most closely in touch with the local weather; ideally it would be issued to a few key national and regional centres for onward distribution within the organization.

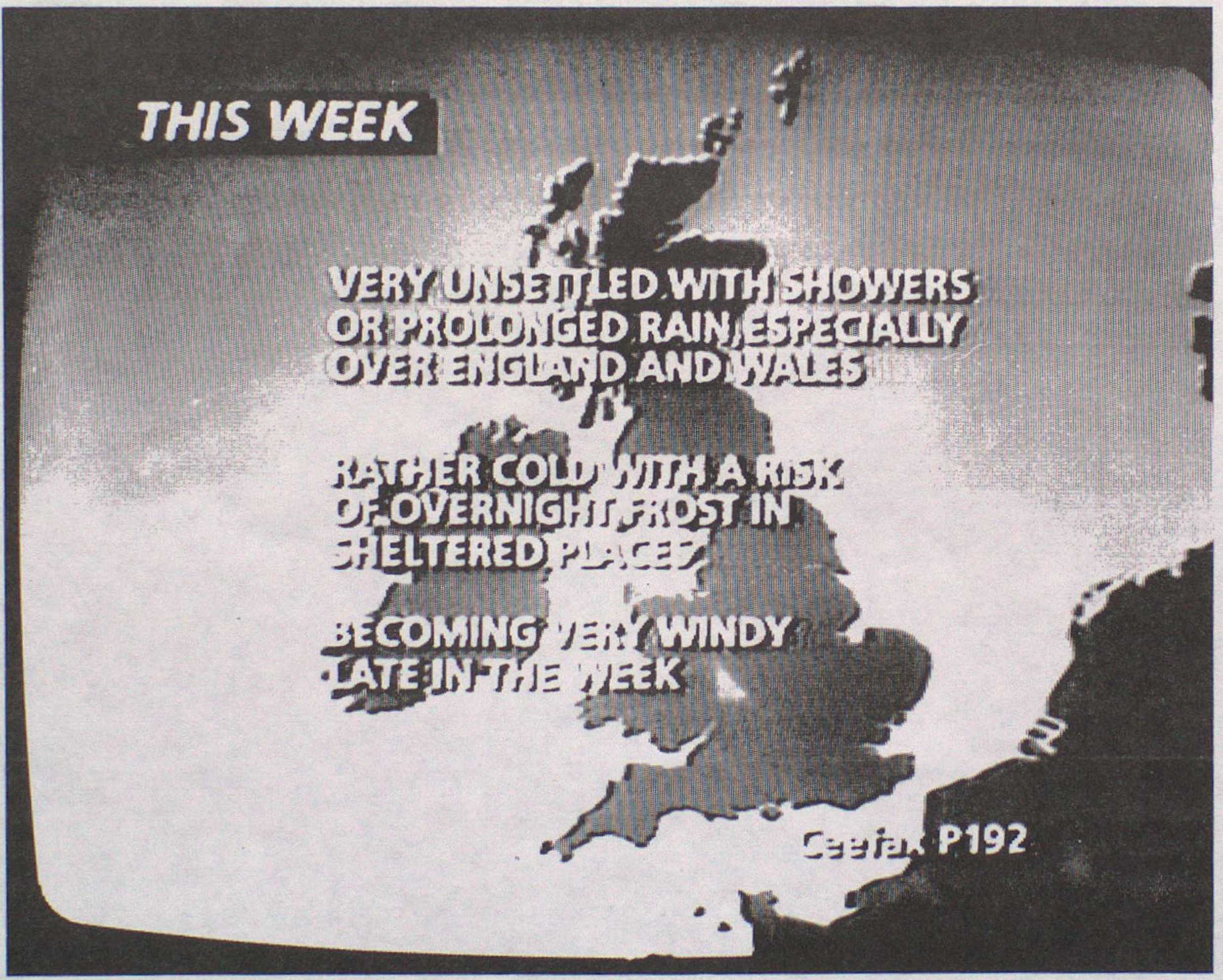
List of Annexes

Annex 4.1	Extract from 'Weather for Farmers', BBC 1, 1258, 11 October 1987.
Annex 4.2	Caption chart shown at conclusion of 'Weather for Farmers', BBC 1, 1258, 11 October 1987.
Annex 4.3	'Weather News', BBC 1, 1325, 14 October 1987.
Annex 4.4(a)	'National Forecast', Radio 4, 0755, 13 October 1987.
Annex 4.4(b)	'National Forecast', Radio 4, 1755, 13 October 1987.
Annex 4.5	Forecasts for the Automobile Association issued on 12, 13 and 14 October 1987.
Annex 4.6	Weathercall extended forecasts (telephone service) issued on 12, 13 and 14 October 1987.
Annex 4.7	Message from Norwich Weather Centre to London Weather Centre concerning the risk of flooding.
Annex 4.8(a)	'Weather News', BBC 1, 1325, 15 October 1987.
Annex 4.8(b)	'Weather News', BBC 1, 1833, 15 October 1987.
Annex 4.8(c)	'Weather News', BBC 1, 2128, 15 October 1987.
Annex 4.9(a)	Local television forecasts, 'Look East', BBC East, 1850, 15 October 1987.
Annex 4.9(b)	Local television forecasts, 'South Today', BBC South, 1850, 15 October 1987.
Annex 4.10	Selection of forecasts on Radio 4, local radio and Weathercall.
Annex 4.11	'National Summary', Radio 4, 0020, 16 October 1987.
Annex 4.12	'Weatherview', BBC 2, 2305, 15 October 1987 (recorded 2030).
Annex 4.13	Instructions for issuing FLASH weather messages.
Annex 4.14	Warning message (land) issued 15/16 October 1987.
Annex 4.15	Gale and storm warnings (for shipping) issued 15/16 October 1987.
Annex 4.16	'Inshore waters forecast', Radio Essex, 1800, 15 October 1987.
Annex 4.17	Offshore forecasts for an oil company.
Annex 4.18	'Goodyear Weather Forecast', Superchannel, 1355 GMT, 15 October 1987.
Annex 4.19	Forecast from the French Weather Service, issued 14 October 1987.
Annex 4.20	Gale warnings for 15/16 October issued by the French Weather Service.

Annex 4.1 Extract from 'Weather for Farmers', BBC 1, 1258, 11 October 1987.

... On Tuesday we have got this still very showery west to south westerly run across the country, some rather heavy showers in the south. There will be will some sunshine as well but you have got to watch out for some fairly heavy and prolonged showers coming along. Towards the middle to late part of the week things developing once again out in the Atlantic. This is going to bring more rain across the southern counties of England during the course of Thursday. That will soon pass but then the next system is really getting itself wound up. That is going to bring a spell of rather wet and windy weather across most parts of the country right at the end of the week. Generally speaking a pretty cold week and some squally showers turning up by the weekend. That's it from me and I will leave you with a summary of the weeks weather.

Annex 4.2 Caption chart shown at conclusion of 'Weather for Farmers', BBC 1, 1258, 11 October 1987.



THIS WEEK

VERY UNSETTLED WITH SHOWERS
OR PROLONGED RAIN, ESPECIALLY
OVER ENGLAND AND WALES

RATHER COLD WITH A RISK
OF OVERNIGHT FROST IN
SHELTERED PLACES

BECOMING VERY WINDY
LATE IN THE WEEK

Ceefax P192

Annex 4.3 'Weather News', BBC 1, 1325, 14 October 1987.

The weather is certainly not looking very nice for golf or for any thing else come to that. It is in a very unsettled mood, quite an angry mood I should think when it comes to tomorrow. Even now we have an area of low pressure developing on our doorstep and that is going to produce a lot of rain over most parts of the country during the course of today. But it is the next one out here on the Atlantic that's the main item of interest. That is going to deepen like mad and head up and give us an angry spell of weather, wet and windy with it. Here at the moment on the satellite picture is the first sort of bulge in the cloud. That is where the first of the areas of low pressure is developing and then out here to the west is the next one. So lets have a look at the way the rainfall is going to go in the next 24 hours or so. You can see at the moment it is beginning to push into the southwest and a fair number of showers scattered around in other parts as well. As I run this sequence watch the way the first of those areas of rain moves quite smartly up the country during today and tonight and then by this time tomorrow the next great area of rain already into southern parts of the country. So as far as today is concerned, just a short time ago before I came down to the studio on the radar it looked as if the rain was now getting well into southwestern parts of England. Some showers running in along the Channel coast and a fair number of showers further north and one or two of those showers still on the heavy side with a rumble or two of thunder. But I think most of the showers that are left over England and Wales will die away as the cloud continues to thicken this afternoon and in Northern Ireland too they will tend to perhaps merge into some more pronounced outbreaks of rain and generally by the end of the afternoon there will be rain into Wales and many southern parts of England as well. Still some showers though continuing further north over Scotland, the odd one on the heavy side. Not a particularly warm afternoon anywhere either 13°C for instance there is 55 F.

Now during this evening the rain continuing to work northwards getting up into southern Scotland and some of the rain incidentally fairly heavy but somewhat clearer weather coming into the southwest before the evening's out and most of England and Wales clearing up during the course of the night and as skies clear so we may well find one or two short-lived mist and fog patches. The odd shower coming in around those western and southern coasts and still a fair bit of rain into the night over most of Scotland except that is the far northeast. Temperatures I think holding up quite reasonably tonight, the wind picking up all the while. There's the chart for this time tomorrow. Not a very nice one at all. A large area of low pressure coming our way, a deep one at that, lots of isobars, lots of wind so that means to say although England and Wales and Northern Ireland starting off bright tomorrow some rain in Scotland, it won't be long before it clouds over and certainly over most of England and Wales with the exception of possibly the west of Wales ending up really wet and windy with it. Further north remaining quite bright with some showers. By Friday the frontal system, an area of low pressure will be out of the way heading up towards Scandinavia but still a lot of isobars as you see so a mixture of sunshine and a fair number of squally showers on Friday.

Annex 4.4(a) 'National Forecast', Radio 4, 0755, 13 October 1987.

FPUK43 EGRB 130700
0755 RADIO 4 BROADCAST - TUESDAY 13TH OCTOBER 1987 - NIGEL GAIT

GOOD MORNING.

OVER AN INCH OF RAIN IN PARTS OF KENT OVERNIGHT, WITH MORE SHOWERS TO COME DURING TODAY, MOST OF THEM IN SOUTHERN AND WESTERN REGIONS BUT THERE WILL BE SOME FURTHER INLAND AS MINOR TROUGHS MOVE EASTWARDS IN THE SOUTHWESTERLY FLOW.

A LOOK FIRST AT SOUTHERN COUNTIES OF ENGLAND, WALES AND NORTHWEST ENGLAND. AND HERE A FAIRLY SHOWERY DAY, SOME PARTS STARTING OFF DRY AND BRIGHT BUT THERE ARE SOME HEAVY SHOWERS IN THE SOUTHWEST NOW AND THESE WILL BECOME MORE WIDESPREAD DURING THE MORNING, SOME OF THEM WITH HAIL AND THUNDER. THERE WILL BE SOME SUNNY SPELLS AS WELL LIFTING THE TEMPERATURE TO BETWEEN 12 AND 14C, THE MID 50SF. WINDS TODAY A MODERATE TO FRESH SOUTHWESTERLY, QUITE STRONG IN THE SOUTHWEST.

OVER THE REST OF ENGLAND, THAT'S ALL CENTRAL AND EASTERN PARTS, SOME RAIN TO CLEAR FROM THE EXTREME EAST FAIRLY SOON AND THEN A DRY SPELL WITH SOME SUNSHINE THIS MORNING. FURTHER CLOUD WILL BRING SOME SHOWERS LATER THIS MORNING AND AFTERNOON, WITH PERHAPS SOME HEAVY ONES. TOP TEMPERATURES 12C IN THE NORTH, 14 FURTHER SOUTH, WITH A LIGHT TO MODERATE SOUTH TO SOUTHWEST WIND.

NOW NORTHERN IRELAND AND SCOTLAND, WHERE THERE'S QUITE A WIDE VARIATION OF WEATHER AT THE MOMENT. SOME EASTERN PARTS OF SCOTLAND STARTING FROSTY AND ONE OR TWO FOG PATCHES, THESE SOON CLEARING, THERE'S SOME RAIN IN THE SOUTHEAST OF SCOTLAND, WHILE ELSEWHERE CLOUD IS BROKEN WITH SOME SHOWERS. THERE WILL BE MORE SHOWERS DURING THE DAY, SOME OF THEM HEAVY AND PROLONGED OVER NORTHERN IRELAND AND WESTERN SCOTLAND. THERE WILL ALSO BE SUNNY SPELLS, THE BEST OF THE SUN IN THE NORTH AND EAST OF SCOTLAND. HIGHEST TEMPERATURES 11C, 52F, WITH A MODERATE TO FRESH SOUTH TO SOUTHEAST WIND.

THIS EVENING AND TONIGHT FURTHER SHOWERS IN THE SOUTH AND WEST, NORTHEASTERN AREAS MOSTLY DRY WTIH A TOUCH OF FROST.

ON WEDNESDAY ANOTHER DAY OF SHOWERS AND SUNNY SPELLS BUT ON THURSDAY A DEEPENING DEPRESSION WILL BRING WET AND VERY WINDY WEATHER FROM THE SOUTHWEST.

AND THAT ENDS THE FORECAST.

Annex 4.4(b) 'National Forecast', Radio 4, 1755, 13 October 1987.

FPUK43 EGRB 131700
1755 RADIO 4 BROADCAST ON TUESDAY 13TH OCTOBER 1987 - JOHN KETLEY

GOOD EVENING.

MANY REGIONS HAVE CAUGHT A DOWNPOUR TODAY AS LOW PRESSURE TO THE WEST OF SCOTLAND CONTINUES TO FEED SHOWERS ACROSS THE COUNTRY. CHANGES IN THE NEXT TWENTY-FOUR HOURS WILL BE RATHER SLOW AND SUBTLE BUT THE DISTRIBUTION OF THE MORE WIDESPREAD AND HEAVY SHOWERS WILL BE SLIGHTLY DIFFERENT.

STARTING THEN WITH ENGLAND AND WALES. AT THE MOMENT A GOOD NUMBER OF HEAVY SHOWERS AROUND, SOME HAIL AND THUNDER AS WELL BUT MANY INLAND PARTS ARE GOING TO BECOME DRY IN THE NEXT TWO OR THREE HOURS, A FEW SHOWERS THOUGH KEEPING GOING NEAR SOUTHERN AND WESTERN COASTS AND QUITE A NUMBER FEEDING THROUGH THE BRISTOL CHANNEL FOR A TIME TOO. SO WITH WELL BROKEN CLOUD OVERNIGHT TEMPERATURES THEN DOWN TO 4 TO 6 DEGREES ABOUT 40F BUT NEARER 8 OR 9 ON WINDWARD COASTS. THE WINDS A LIGHT SOUTH TO SOUTHWESTERLY BUT STAYING FAIRLY BRISK IN THE WEST COUNTRY. TOMORROW THERE WILL BE A LOT OF DRY AND SUNNY WEATHER AROUND AT FIRST BUT SOUTHERN AND WESTERN COASTS WILL ALREADY HAVE A FEW SHOWERS AND A FEW MORE WILL FEED INLAND AS THE DAY GOES ALONG BUT MANY EASTERN PARTS PROBABLY MISSING THE SHOWERS ALTOGETHER AND STAYING QUITE DRY AND SUNNY. BUT INCREASING CLOUD WILL BE DEVELOPING FROM THE SOUTH AS THE DAY GOES ALONG AND THERE WILL BE HEAVY RAIN INTO SOUTH WALES AND SOUTHWEST ENGLAND DURING THE AFTERNOON, THIS RAIN EXTENDING TO MOST OTHER PLACES AFTER DARK. IT WILL BE A RATHER COLD DAY ONCE AGAIN, TEMPERATURES VERY MUCH LIKE THEY WERE TODAY 13 TO 15, THAT'S THE UPPER 50'SF AND A FRESHENING SOUTHERLY BREEZE.

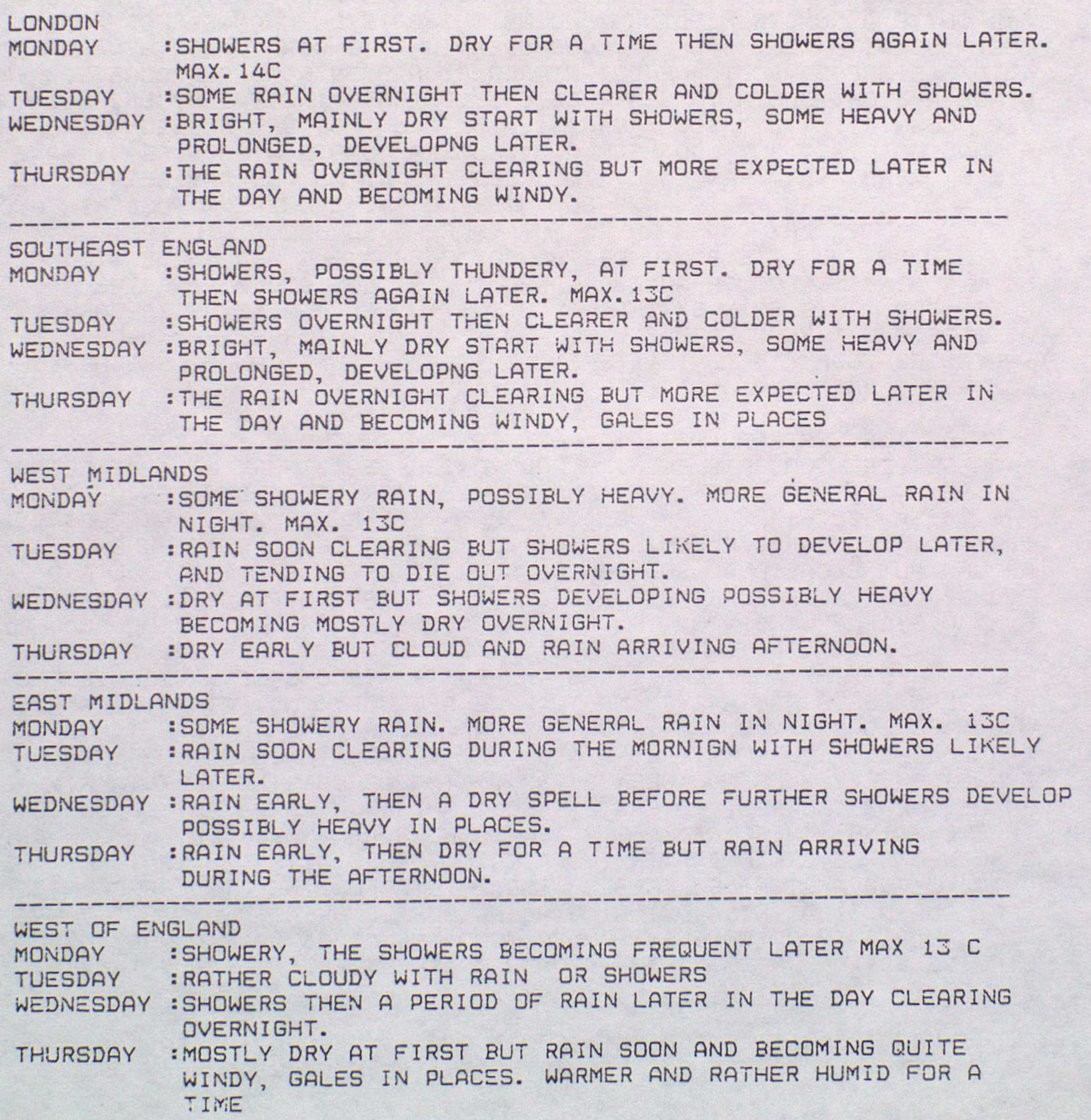
AND NOW FOR NORTHERN IRELAND AND WESTERN SCOTLAND. A CROP OF SHOWERS HERE TOO THIS EVENING AND TONIGHT BUT THERE WILL BE CLEAR PERIODS AND THIS WILL TAKE TEMPERATURES DOWN TO 5 DEGREES OR 41F AND THE BRISK SOUTHERLY WIND VEERING SOUTHWESTERLY OVER IN NORTHERN IRELAND. TOMORROW A SIMILAR DAY TO TODAY REALLY, SOME SUNSHINE AROUND BUT OCCASIONAL SHOWERS AS WELL WITH THE RISK OF HAIL AND THUNDER. TEMPERATURES RESTRICTED BY A FAIRLY STRONG SOUTH OR SOUTHWESTERLY WIND, TOP TEMPERATURE ABOUT 11 OR 12, THE LOW 50'SF.

AND NOW FOR THE NORTHERN ISLES AND EASTERN SCOTLAND. WELL IN THE NORTHERN ISLES YOU ARE GOING TO HAVE A CLOUDY AND RATHER SHOWERY NIGHT FOLLOWED BY SUNNY INTERVALS AND OCCASIONAL SHOWERS TOMORROW AND A STRONG SOUTHEASTERLY WIND. THE TEMPERATURES NOT REALLY CHANGING VERY MUCH, BETWEEN 8 AND 10 THROUGHOUT THE NEXT TWENTY-FOUR HOURS. FOR THE REST OF EASTERN SCOTLAND IT WILL BE RATHER CLOUDY THIS EVENING, THERE WILL BE A FEW SHOWERS AROUND, IT WILL TURN DRIER AND CLEARER OVERNIGHT WITH THE RISK OF FROST WITH TEMPERATURES THEN 0 TO +3 AND A LIGHT SOUTHERLY WIND. TOMORROW THE WIND FRESHENING ONCE AGAIN, THAT WIND BRINGING A FEW MORE SHOWERS ALONG BUT THERE WILL BE PLENTY OF SUNSHINE AND A GOOD CHANCE OF MANY PLACES ACTUALLY STAYING DRY AND MISSING THE SHOWERS ALTOGETHER. THE TOP TEMPERATURE 11, (52).

AND THE OUTLOOK IS FOR A LOT OF WET AND WINDY WEATHER SPREADING NORTHEASTWARDS ACROSS THE COUNTRY FROM THE SOUTHWEST.

AND NOW BACK TO EDWARD COLE.

Annex 4.5 Forecasts for the Automobile Association issued on 12, 13 and 14 October 1987.



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923378 AA STM G
24644  WEALWC G
ZCZC
TO   :AA ROADWATCH CENTRE                        FILE REF:T/5
FROM :LONDON WEATHER CENTRE

WEATHER FORECAST FOR THE NEXT FIVE DAYS ISSUED ON MONDAY 12TH
OCTOBER 1987.

SUMMARY    :STILL A VERY UNSETTLED WEATHER PICTURE FOR ALL OF BRITAIN AS
DEPRESSIONS MOVE EAST ACROSS THE ATLANTIC BRINGING WEATHER FRONTS
OVER BRITAIN.
----------------------------------------------------------------
LONDON
MONDAY     :SHOWERS AT FIRST. DRY FOR A TIME THEN SHOWERS AGAIN LATER.
            MAX.14C
TUESDAY    :SOME RAIN OVERNIGHT THEN CLEARER AND COLDER WITH SHOWERS.
WEDNESDAY :BRIGHT, MAINLY DRY START WITH SHOWERS, SOME HEAVY AND
            PROLONGED, DEVELOPNG LATER.
THURSDAY   :THE RAIN OVERNIGHT CLEARING BUT MORE EXPECTED LATER IN
            THE DAY AND BECOMING WINDY.
----------------------------------------------------------------
SOUTHEAST ENGLAND
MONDAY     :SHOWERS, POSSIBLY THUNDERY, AT FIRST. DRY FOR A TIME
            THEN SHOWERS AGAIN LATER. MAX.13C
TUESDAY    :SHOWERS OVERNIGHT THEN CLEARER AND COLDER WITH SHOWERS.
WEDNESDAY :BRIGHT, MAINLY DRY START WITH SHOWERS, SOME HEAVY AND
            PROLONGED, DEVELOPNG LATER.
THURSDAY   :THE RAIN OVERNIGHT CLEARING BUT MORE EXPECTED LATER IN
            THE DAY AND BECOMING WINDY, GALES IN PLACES
----------------------------------------------------------------
WEST MIDLANDS
MONDAY     :SOME SHOWERY RAIN, POSSIBLY HEAVY. MORE GENERAL RAIN IN
            NIGHT. MAX. 13C
TUESDAY    :RAIN SOON CLEARING BUT SHOWERS LIKELY TO DEVELOP LATER,
            AND TENDING TO DIE OUT OVERNIGHT.
WEDNESDAY :DRY AT FIRST BUT SHOWERS DEVELOPING POSSIBLY HEAVY
            BECOMING MOSTLY DRY OVERNIGHT.
THURSDAY   :DRY EARLY BUT CLOUD AND RAIN ARRIVING AFTERNOON.
----------------------------------------------------------------
EAST MIDLANDS
MONDAY     :SOME SHOWERY RAIN. MORE GENERAL RAIN IN NIGHT. MAX. 13C
TUESDAY    :RAIN SOON CLEARING DURING THE MORNIGN WITH SHOWERS LIKELY
            LATER.
WEDNESDAY :RAIN EARLY, THEN A DRY SPELL BEFORE FURTHER SHOWERS DEVELOP
            POSSIBLY HEAVY IN PLACES.
THURSDAY   :RAIN EARLY, THEN DRY FOR A TIME BUT RAIN ARRIVING
            DURING THE AFTERNOON.
----------------------------------------------------------------
WEST OF ENGLAND
MONDAY     :SHOWERY, THE SHOWERS BECOMING FREQUENT LATER MAX 13 C
TUESDAY    :RATHER CLOUDY WITH RAIN  OR SHOWERS
WEDNESDAY :SHOWERS THEN A PERIOD OF RAIN LATER IN THE DAY CLEARING
            OVERNIGHT.
THURSDAY   :MOSTLY DRY AT FIRST BUT RAIN SOON AND BECOMING QUITE
            WINDY, GALES IN PLACES. WARMER AND RATHER HUMID FOR A
            TIME
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24644  WEALWC G
ZCZC
TO   :AA ROADWATCH CENTRE                          FILE REF:T/5
FROM :LONDON WEATHER CENTRE

WEATHER FORECAST FOR THE NEXT FIVE DAYS ISSUED ON TUESDAY 13TH
OCTOBER 1987.

SUMMARY     :REMAINING UINSETTLED IN ALL AREAS WITH A MAJOR STORM
             CROSSING BRITAIN FROM THE SOUTHWEST DURING THURSDAY AND
             FRIDAY
-----------------------------------------------------------------------
LONDON_
TUESDAY     :DRY AND BRIGHT FOR MUCH OF THE TIME BUT SOME SHOWERS
             CROSSING THE AREA DURING THE DAY
WEDNESDAY   :A FEW SHOWERS
THURSDAY    :DRY AT FIRST, THEN RAIN HEAVY AT TIMES AND BECOMING
             VERY WINDY
FRIDAY      :STORMY AT FIRST, SLOWLY BECOMING LESS WINDY. RAIN THEN
             BRIGHTER WITH SHOWERS
-----------------------------------------------------------------------
SOUTHEAST ENGLAND
TUESDAY     :A MIXTURE OF SUNSHINE AND SHOWERS, THE SHOWERS HEAVIER
             AND MORE FREQUENT NEAR  THE SOUTH COAST. MAX 14 DEG C
WEDNESDAY   :A FEW HEAVY SHOWERS, ESPECIALLY NEAR THE SOUTH COAST.
THURSDAY    :MOSTLY DRY AT FIRST, BUT SOON BECOMING CLOUDY WITH
             HEAVY RAIN SPREADING FROM THE SOUTHWEST. BECOMING VERY
             WINDY WITH GALES OR STORM FORCE WINDS DEVELOPING.
FRIDAY      :STORMY AT FIRST, THEN SLOWLY BECOMING LESS WINDY. RAIN
             AT FIRST THE BRIGHTER BUT SHOWERY WITH SOME HEAVY AND
             THUNDERY SHOWERS
-----------------------------------------------------------------------
WEST MIDLANDS
TUESDAY     :MIXTURE OF SUNSHINE AND SHOWERS, SOME OF THE SHOWERS
             HEAVY AND PERHAPS THUNDERY. MAX 13 DEG C
WEDNESDAY   :FURTHER SUNSHINE AND SHOWERS
THURSDAY    :STARTING DRY AND BRIGHT BUT BECOMING CLOUDIER WITH SOME
             HEAVY RAIN SPREADING FROM THE SOUTHWEST. BECOMING VERY
             WINDY WITH WINDS REACHING GALE FORCE.
FRIDAY      :STORMY AT FIRST BUT WINDS SLOWLY EASING LATER IN THE
             DAY.RAIN AT FIRST BUT BECOMING BRIGHTER AND
             SHOWERY DURING THE DAY. SOME OF THE SHOWERS HEAVY.
-----------------------------------------------------------------------
EAST MIDLANDS
TUESDAY     :SUNNY SPEWLLS AND SOME SCATTERED SHOWERS. MAX 14 DEG C
WEDNESDAY   :SUNNY SPELLS AND SOME SHOWERS
THURSDAY    :DRY AT FIRST WITH SOME MIST PATCHES. HEAVY RAIN
             SPREADING FROM THE SOUTHWEST DURING THE DAY AND
             BECOMING VERY WINDY.
FRIDAY      :STORMY FOR MUCH OF THE DAY WITH RAIN SLOWLY GIVING WAY
             TO CLEARER SHOWERY WEATHER.
-----------------------------------------------------------------------
WEST OF ENGLAND
TUESDAY     :SUNNY INTERVALS WITH FREQUENT AND HEAVY SHOWERS, SOME
             TURNING THUNDERY.
WEDNESDAY   :SUNNY INTERVALS AND HEAVY AND THUNDERY SHOWERS
THURSDAY    :WET AND VERY WINDY WEATHER SOON SPREADING FROM THE
             SOUTHWEST. SOME OF THE RAIN HEAVY AND WINDS BECOMING
             STORM FORCE, ESPECIALLY NEAR COASTS.
FRIDAY      :STORMY AT FIRST BUT WINDS GRADUALLY MODERATING.
             FREQUENTAND HEAVY SHOWERS WITH HAIL AND THUNDER
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922278 AA STM G
24644  WEALKI G
ZCZC
TO    :AA ROADWATCH CENTRE                         FILE REF:T5
FROM  :LONDON WEATHER CENTRE

WEATHER FORECAST FOR THE NEXT FIVE DAYS ISSUED ON WEDNESDAY 14TH
OCTOBER 1987.
SUMMARY    :A VERY UNSETTLED FEW DAYS IS EXPECTED AS FRONTS CROSS
            ALL PARTS FROM TIME TO TIME, AND WITH A DEPRESSION
            EXPECTED TO CROSS THE KINGDOM DURING THURSDAY AND
            FRIDAY SOME WET AND WINDY WEATHER SEEMS
            LIKELY FOR ALL AREAS.

-----------------------------------------------------------------
LONDON
WEDNESDAY : BRIGHT START BUT SHOWERS DEVELOPING, SOME
            HEAVY. MORE GENERAL RAIN OVERNIGHT. MAX 14 DEGS C.
THURSDAY  :PROBABLY DRY, MISTY START BUT RAIN, PERSISTENT AND
            OCCASIONALLY HEAVY WILL SOON SPREAD OVER, IT WILL BE
            WINDY. RAIN PROBABLY CLEARING TOWARDS END OF DAY.
FRIDAY    :A DAY OF SUNNY INTERVALS AND FREQUENT BLUSTERY,
            SOMETIMES HEAVY, SHOWERS.
            STRONG SOUTHWESTERLY WINDS MODERATING LATER IN THE DAY.
SATURDAY  :SUNNY INTERVALS AND OCCASIONAL SHOWERS.
-----------------------------------------------------------------
SOUTHEAST ENGLAND
WEDNESDAY : BRIGHT START EXCEPT NEAR THE SOUTH COAST
            WHERE SHOWERS ARE LIKELY THROUGHOUT, BUT SHOWERS
            DEVELOPING GENERALLY, SOME HEAVY. MORE GENERAL RAIN
            OVERNIGHT. MAX 13 DEGS C.
THURSDAY  :PROBABLY SOME EARLY FOG BUT RAIN, PERSISTENT AND
            OCCASIONALLY HEAVY (WITH FOG ON HIGHERST HILLS),WILL
            SOON SPREAD OVER, IT WILL BE WINDY. RAIN PROBABLY
            CLEARING TOWARDS END OF DAY.
FRIDAY    :A DAY OF SUNNY INTERVALS AND FREQUENT BLUSTERY,
            SOMETIMES HEAVY, SHOWERS.
            STRONG SOUTHWESTERLY WINDS MODERATING LATER IN THE DAY.
SATURDAY  :SUNNY INTERVALS AND OCCASIONAL SHOWERS.
-----------------------------------------------------------------
WEST MIDLANDS
WEDNESDAY : MAINLY BRIGHT START BUT SHOWERS DEVELOPING,
            SOME HEAVY. MORE GENERAL RAIN EVENING AND OVERNIGHT.
            MAX 12 DEGS C.
THURSDAY  :PROBABLY SOME EARLY FOG BUT RAIN, PERSISTENT AND
            OCCASIONALLY HEAVY WILL SOON SPREAD OVER,(FOG ON
            HILLS). IT WILL BE WINDY. RAIN PROBABLY CLEARING
            TOWARDS END OF DAY.
FRIDAY    :A DAY OF SUNNY INTERVALS AND FREQUENT BLUSTERY,
            SOMETIMES HEAVY, SHOWERS.
            STRONG SOUTHWESTERLY WINDS MODERATING LATER IN THE DAY.
SATURDAY  :SUNNY INTERVALS AND OCCASIONAL SHOWERS.
-----------------------------------------------------------------
EAST MIDLANDS
WEDNESDAY : BRIGHT START BUT SHOWERS DEVELOPING,
            SOME HEAVY. MORE GENERAL RAIN OVERNIGHT.
            MAX 12 DEGS C.
THURSDAY  :MIST AND RAIN AT FIRST, THEN DRY FOR A WHILE, BUT
            RAIN, PERSISTENT AND OCCASIONALLY HEAVY WILL SPREAD
            OVER, IT WILL BECOME WINDY. RAIN PROBABLY CLEARING
            DURING THE EVENING. FOG ON HIGHEST HILLS).
FRIDAY    :A DAY OF SUNNY INTERVALS AND FREQUENT BLUSTERY,
            SOMETIMES HEAVY, SHOWERS.
            STRONG SOUTHWESTERLY WINDS MODERATING LATER IN THE DAY.
SATURDAY  :SUNNY INTERVALS AND OCCASIONAL SHOWERS.
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Annex 4.6 Weathercall extended forecasts (telephone service) issued on 12, 13 and 14 October 1987.

265974 TELINF G
24644 WEALWC G
ZCZC
TO TIS FOR WEATHERCALL - EXTENDED FORECAST
FROM: LONDON WEATHER CENTRE FILE REF: R10

HERE IS THE FURTHER OUTLOOK FOR ENGLAND, WALES, SCOTLAND AND NORTHERN IRELAND FOR WEDNESDAY, THURSDAY AND FRIDAY ISSUED MONDAY 12TH OCTOBER 1987.

IT'S STILL A VERY UNSETTLED WEATHER PICTURE FOR ALL OF BRITAIN AS DEPORESSIONS MOVE EAST ACROSS THE ATLANTIC BRINGING WEATHER FRONTS OVER BRITAIN. SO ALL PARTS WILL HAVE RAIN OR SHOWERS BUT ALSO SOME CLEARER DRIER PERIODS. TEMPERATURES GENERALLY WILL BE A LITTLE BELOW THE AVERAGE FOR THIS TIME OF THE YEAR.

NOW FOR THE OUTLOOK IN MORE DETAIL

ON WEDNESDAY MANY EASTERN AND CENTRAL AREAS WILL START DRY AND BRIGHT BUT THE SHOWERY WEATHER IN THE WEST WILL SPREAD TO ALL OF THE COUNTRY DURING THE DAY. SOME OF THE SHOWERS WILL BE HEAVY AND LENGTHY, POSSIBLY WITH THUNDER IN THE NORTH AND WEST. IT WILL BECOME QUITE WINDY AND BE RATHER COLD IN PLACES.

ON THURSDAY RATHER CLOUDY WEATHER WITH RAIN OVER NORTHEASTERN PARTS OF ENGLAND AND OVER SCOTLAND WILL MOVE AWAY GIVING A DRIER, BRIGHTER SPELL. HOWEVER RAIN IS EXPECTED TO REACH THE SOUTHWEST QUITE EARLY AND SPREAD ACROSS MOST OF THE COUNTRY BY THE END OF THE DAY. IT WILL BECOME VERY WINDY ESPECIALLY IN THE SOUTH WHERE GALES ARE LIKELY. TEMPERATURES SHOULD RISE TO NEAR THE NORMAL IN THE VERY MOIST AIR.

THEN ON FRIDAY, EVERYWHERE SEEMS LIKELY TO HAVE A MIXTURE OF SUNNY INTERVALS AND BLUSTERY SHOWERS, SOME HEAVY, AND IT WILL TURN COLDER AGAIN.

NNNN

24644 WEALWC G
265974 TELINF G

265974 TELINF GN
24644 -WEALWC G
ZCZC
TO TIS FOR WEATHERCALL - EXTENDED FORECAST
FROM: LONDON WEATHER CENTRE FILE REF: R10

HERE IS THE FURTHER OUTLOOK FOR ENGLAND, WALES, SCOTLAND AND NORTHERN IRELAND FOR THURSDAY, FRIDAY AND SATURDAY ISSUED TUESDAY 13TH OCTOBER 1987.

THE UNSETTLED WEATHER WILL CONTINUE AND IT WILL BECOME VERY WINDY AS A VERY DEEP LOW PRESSURE AREA MOVES INTO SOUTHWEST BRITAIN ON THURSDAY AND TRACKS NNE-WARDS TOWARDS NORTHEAST SCOTLAND DURING FRIDAY. WINDS WILL REACH GALE OR EVEN STORM FORCE IN MANY AREAS.

NOW FOR THE OUTLOOK IN MORE DETAIL:-

THURSDAY 15TH OCTOBER.
NORTHERN BRITAIN WILL BE RATHER SHOWERY WITH ONLY A FEW BRIGHT OR SUNNY INTERVALS. MOST OTHER PARTS OF THE COUNTRY WILL START BRIGHT AND DRY BUT WET AND WINDY WEATHER IN THE SOUTH WEST WILL QUICKLY SPREAD TO THR REMAINDER OF ENGLAND AND WALES AND MAY EVEN REACH NORTHERN IRELAND AND SOUTHERN SCOTLAND BY THE END OF THE DAY. THE RAIN WILL BE HEAVY AT TIMES AND IT WILL FEEL COLD IN THE VERY STRONG WINDS.

FRIDAY 16TH OCTOBER
STORMY IN MANY AREAS, WITH FREQUENT HEAVY SHOWERS AND SOME MORE PROLONGED RAIN CHIEFLY IN THE NORTH AND WEST. HOWEVER, WINDS WILL SLOWLY EASE FROM THE SOUTH LATER IN THE DAY BUT IT WILL STAY VERY WINDY IN THE NORTH AND IT WILL STILL FEEL VERY COLD .

SATURDAY 17TH OCTOBER
NORTHERN SCOTLAND WILL BE RATHER WET AND WINDY BUT REMAINING AREAS WILL HAVE A MIXTURE OF SUNSHINE AND SHOWERS. THE SHOWERS WILL BE MORE FREQUENT IN THE NORTH AND WEST WITH THE BEST OF THE SUNSHINE IN THE EAST. LATE IN THE DAY SOME MORE GENERAL RAIN MAY REACH SOME WESTERN DISTRICTS. IT WILL FEEL A LITTLE WARMER GENERALLY.

NNNN

24644 WEALWC G
265974 TELINF GN

265974 TELINF G
24644 WEALWC G
ZCZC
TO TIS-FOR WEATHERCALL - EXTENDED FORECAST
FROM: LONDON WEATHER CENTRE FILE REF: R10

HERE IS THE FURTHER OUTLOOK FOR ENGLAND, WALES, SCOTLAND AND NORTHERN IRELAND FOR FRIDAY, SATURDAY AND SUNDAY.
ISSUED WEDNESDAY 14TH OCTOBER 1987.

THE VERY WET AND WINDY WEATHER OF THURSDAY IS EXPECTED TO EASE AWAY SLOWLY, ALTHOUGH IT WILL STILL BE WINDY FOR A WHILE, ESPECIALLY IN THE NORTH, AND MOST PLACES ARE EXPECTED TO HAVE SOME SHOWERS. BY SUNDAY HOWEVER ANOTHER DEPRESSION IS EXPECTED TO PASS OVER THE COUNTRY, AND ONCE AGAIN A WET AND WINDY SPELL SEEMS LIKELY FOR MOST AREAS.

NOW FOR THE OUTLOOK IN MORE DETAIL:

ON FRIDAY; RAIN, HEAVY AT TIMES AND WITH WIDESPREAD HILL FOG OVER NORTHERN AND EASTERN SCOTLAND AT FIRST WILL SOON CLEAR AWAY, AND THEN ALONG WITH ALL OTHER PARTS OF THE KINGDOM IT IS EXPECTED TO BE A DAY OF SUNNY INTERVALS AND FREQUENT BLUSTERY SHOWERS. IN NORTHERN IRELAND, WESTERN AND NORTHERN SCOTLAND, WALES AND THE WESTERN HALF OF ENGLAND, SHOWERS ARE MOST LIKELY TO BE HEAVY AND SQUALLY AT TIMES. IT WILL BE VERY WINDY GENERALLY, AND ALTHGOUGH TEMPERATURES WILL PROBABLY BE AROUND THE SAME AS ON THURSDAY, WITH THE STRONG WIND IT WILL FEEL RATHER COLD.

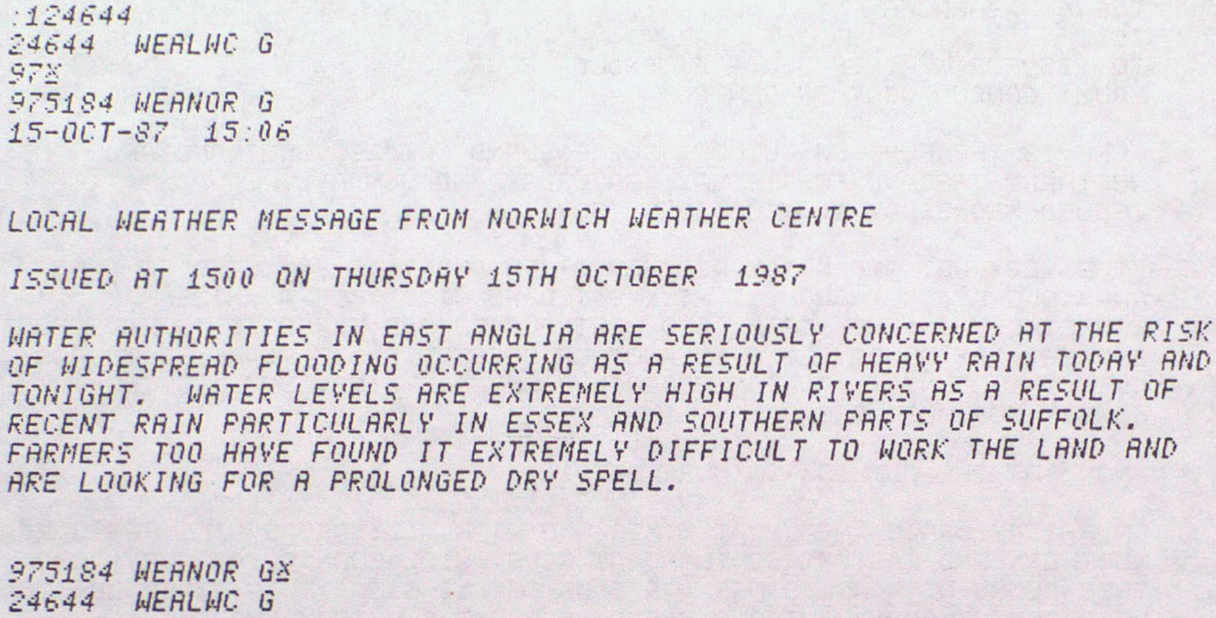
ON SATURDAY; THE SUNNY INTERVALS AND SHOWERS OF FRIDAY LOOK SET TO CONTINUE INTO SATURDAY, AGAIN WITH THE WESTERN SIDE OF THE KINGDOM BEING MOST LIKELY TO HAVE THE HEAVIEST AND MOST FREQUENT SHOWERS. OVER MOST AREAS THE WIND IS EXPECTED TO EASE AND IT WILL FEEL A LITTLE WARMER, BUT AROUND NORTHERN AND WESTERN SCOTLAND IT WILL REMAIN RATHER COLD AND THE STRONG SOUTHWESTERLY WINDS SEEM LIKELY TO PERSIST FOR MOST OF THE DAY. TOWARDS EVENING SOUTHWEST ENGLAND IS EXPECTED TO BECOME MORE GENERALLY CLOUDY AS THE FIRST SIGNS OF THE NEXT ATLANTIC DEPRESSION BEGIN TO SHOW.

ON SUNDAY; NORTHERN PARTS OF SCOTLAND WILL PROBABLY HAVE A FEW SHOWERS AT FIRST, BUT THESE WILL DIE AWAY DURING THE MORNING BEFORE MORE GENERAL RAIN SPREADS OVER LATER IN THE DAY.
OVER SOUTHWEST ENGLAND CLOUD WILL CONTINUE TO THICKEN, AND RAIN WILL SOON FOLLOW AND THEN SPREAD QUICKLY NORTHEASTWARDS TO MOST OTHER AREAS DURING THE DAY. THE RAIN IS EXPECTED TO BE HEAVY AT TIMES, PARTICULARLY IN THE WEST, AND HILL FOG WILL BE WIDESPREAD.

NNNN

24644 WEALWC G
265974 TELINF G

Annex 4.7 Message from Norwich Weather Centre to London Weather Centre concerning the risk of flooding.



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:124644
24644  WEALWC G
97X
975184 WEANOR G
15-OCT-87  15:06


LOCAL WEATHER MESSAGE FROM NORWICH WEATHER CENTRE

ISSUED AT 1500 ON THURSDAY 15TH OCTOBER  1987

WATER AUTHORITIES IN EAST ANGLIA ARE SERIOUSLY CONCERNED AT THE RISK
OF WIDESPREAD FLOODING OCCURRING AS A RESULT OF HEAVY RAIN TODAY AND
TONIGHT.  WATER LEVELS ARE EXTREMELY HIGH IN RIVERS AS A RESULT OF
RECENT RAIN PARTICULARLY IN ESSEX AND SOUTHERN PARTS OF SUFFOLK.
FARMERS TOO HAVE FOUND IT EXTREMELY DIFFICULT TO WORK THE LAND AND
ARE LOOKING FOR A PROLONGED DRY SPELL.


975184 WEANOR GX
24644  WEALWC G
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Annex 4.8(a) 'Weather News', BBC 1, 1325, 15 October 1987.

Good afternoon earlier on today apparently a woman rang the BBC and said she heard that there was a hurricane on the way. Well if you are watching don't worry, there isn't. But having said that actually the weather will become very windy but most of the strong winds incidentally will be down over Spain and across into France as well but there is a vicious looking area of low pressure on our doorstep nevertheless, around the Brittany area and that is going to head across the southeastern corner of the country bringing if nothing else a lot of rain with it. On the satellite picture you can see that there is of course a lot of cloud as well as a lot of rain stretching right across Europe and indeed most areas there are just as unsettled as we are having some outbreaks of rain. That's the way the rainfall pattern is looking at the moment, a lot of shading, a lot of rain across many parts of Europe. Let's zoom in a little bit closer and have a look at the British scene though, as you can see rain is now pushing up towards southern counties and there is a fair bit of rain still further north left over from last nights weather system. Now as I run the sequence you can see just how quickly the rain comes up from France, affects many southern and eastern areas and then eventually later on tonight clears on out of the way and leaves us tomorrow in a fairly stiff run of westerly winds bringing along quite a few showers.

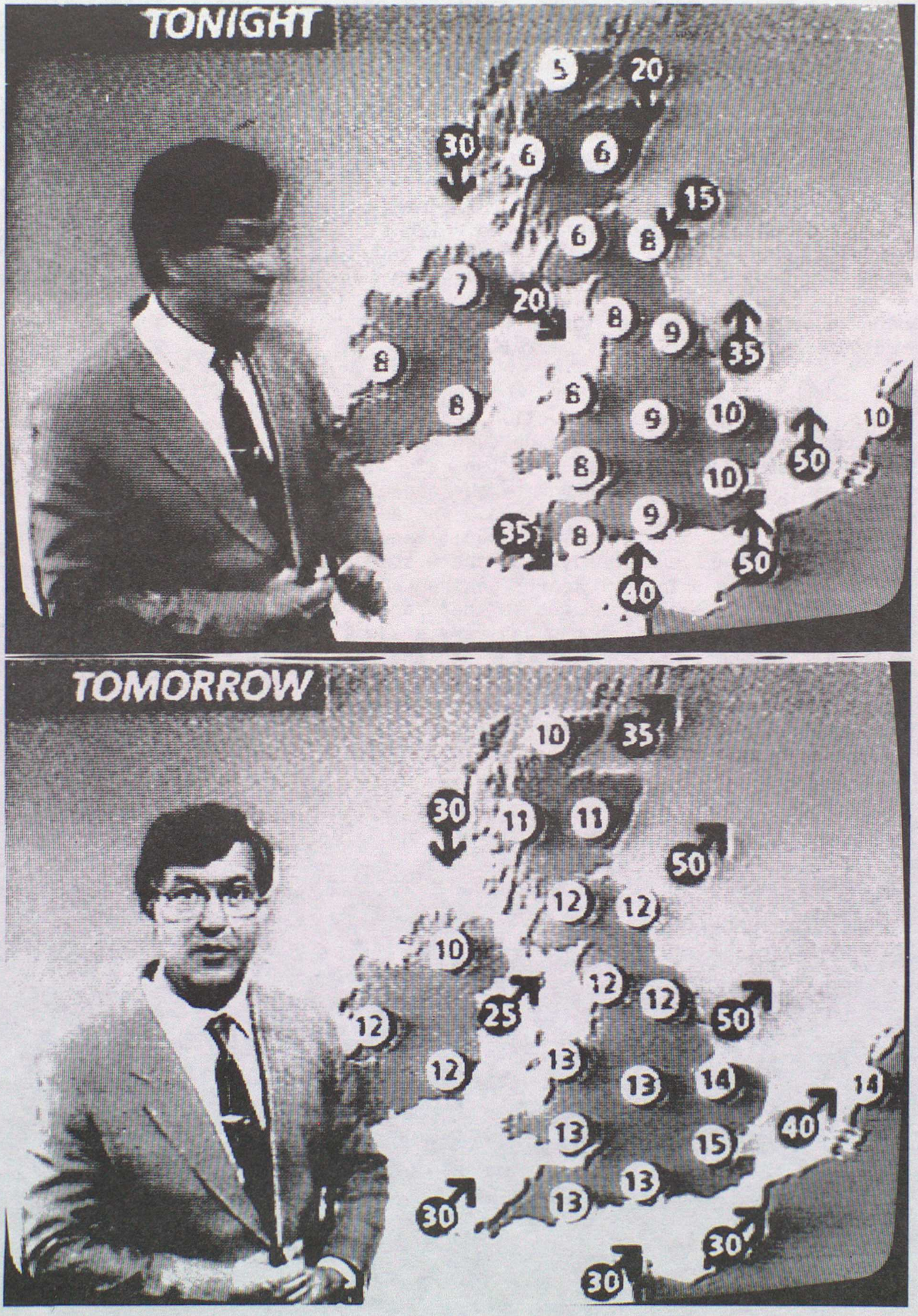
I had a peep at the radar just before I came down a short while ago and it looked as if rain wasn't very far away from the London area but certainly some outbreaks of rain coming nicely now into many southern counties of England. The more Midland areas and Wales are a little bit brighter and drier, just one or two showers around. Northern England, Northern Ireland and Scotland though a fair amount of cloud and again there are some outbreaks of rain and some of the rain fairly heavy although it is beginning to ease off and turn showery now over Northern Ireland. Now as time goes on the rain in the north will edge up into northern parts of Scotland tending to brighten up a little bit and dry up in the more northern areas of England. The rain further south really setting in as time goes on. Through East Anglia, many southern parts of England, the afternoon ending up very wet and quite cool too 12 or 13°C only the mid-50's Fahrenheit. Now to begin with this evening a lot of wet weather around in many eastern and southern parts of the country fairly heavy rain, still some quite heavy rain in that northern part of Scotland as well. But the rain in the north of Scotland will slowly clear away and the rain in the south as well except that is I think in those eastern counties where it will last into the morning and as it clears away the cloud should break but it will leave behind just one or two showers. Becoming quite windy you are going to notice around these southern and southeastern parts as the evening and nights goes on, a reasonably cool night as well. Now there's the picture for tomorrow, stiff westerly winds and that means to say that once the rain clears from the east its a mixture of sunshine and showers, for us all and rather cool with it.

Annex 4.8(b) 'Weather News', BBC 1, 1833, 15 October 1987.

Hello to you. Before you ask I really don't know what the weather's going to be like for the big fight just yet. We're keeping an eye on it for you. All I know is that it has been very disappointing this week and certainly particularly disappointing today, a lot of heavy rain around, some strong winds too in the southeastern quarter this evening. The best way to show you is to set the scene by looking at the satellite picture and you can see the great mass of cloud now which is almost enveloping the British Isles giving some pretty heavy rain and strong winds over the near continent as well. It is associated with this low pressure area and you can see the isobars are particularly close together over France running up through into Belgium coming up into Holland now and that is where the strongest of the winds are likely to be. You can see by the early hours of the morning the low taking its rain northwards across the country but taking the strongest of the winds up the southern part of the North Sea and then during tomorrow going up across into parts of Scandinavia as well. So, some pretty unsettled weather to come for us.

There is a band of rain now which is working its way this afternoon up from the south, some pretty heavy rain mixed in and it will continue to works its way northwards and then a drier spell but there is more rain over central and southern parts of Scotland. That's also going to continue to work its way northwards through the night. With that moving north the next lot moving up too by midnight it will almost have joined although I think in Southern Scotland and Northern Ireland it could still be quite dry there for a little while to come. And then as we go through the latter part of the night clearer weather coming in will push this rain, a lot of it anyway, out into the North Sea and some of it swirling back up into northern parts of Scotland as well. Not a cold night by any means, in fact in the south eastern quarter where it is going to get pretty windy it could be a very mild evening, temperatures around 15°C that is around 60°F but getting a little colder later on. Tomorrow morning then still dull and wet over many central and northern parts of Scotland, quite bright over much of England and Wales although there could be some hang back of cloud on that eastern side and then showers developing down in the south. I think there could be showers almost anywhere through tomorrow even some longer spells of rain in the north, not too many perhaps to the east of the Pennines. Temperatures, well, very much the same as today. Still windy near that eastern coast. That's it from me. Bye Bye.

From the BBC 1 Weather News, 1833 15 October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Annex 4.8(c) 'Weather News', BBC 1, 2128, 15 October 1987.

Hello to you. It was a very disappointing day today in many places. I am optimistic that it is going to be a better day for most of us through tomorrow. A lot of cold wet weather around, the wettest place I have seen up to now is Marham in Norfolk, over an inch of rain there and there is another half an inch to come tonight so a lot of rain there I think by the morning. The coldest place too, and that was very cold today, Belfast only 6°C, 43°F. Now the satellite picture sets the scene it shows the British Isles, in fact it is underneath there somewhere, a lot of cloud and indeed a lot of rain too in the south, another band of wet weather further north as well. Now this one to the south is associated with that low pressure area. It is going to trundle its way across towards the Midlands and it is going to bring these southerly winds up on the eastern side, most of it over the low countries though and behind that low pressure some quite strong northwesterly winds tucking into the southwest already and then as you can see as that low pushes further on then these westerly winds, northwesterly winds are going to be quite strong to start with, I think, on the eastern side of England as well.

So then some damp weather, some wet weather up in the far north, wet weather down in the south as well, the heaviest of the rain I think from now on in the southwest coming up through the western part of the Midlands, that rain eventually coming up to the rain further north But a good deal of this pushing its way tonight or by the end of the night out into the North Sea. Not a cold night by any means. In fact down here in the south its very mild at the moment with these quite strong southwesterly winds but these northwesterlies already into the west country- they will be pushing their way across bringing clearer weather and colder weather too. By the morning then still dull and wet in that far northern part. I think you will find as we go through the day very gradually turning more showery but still a fair number of showers. England and Wales quite bright with some sunshine but most of the showers tomorrow will be on the western side and particularly near these Channel coasts a lot of showers there. Maybe not too many inland. Temperatures certainly round about the same values as today and still quite windy, certainly to start with, on the eastern side. That's it I will be back again tomorrow. I do hope I will see you then. Bye bye.

Annex 4.9(a) Local television forecasts, 'Look East', BBC East, 1850, 15 October 1987.

Up to an inch of rain in places again last night. A slightly drier slot this morning but it is raining again throughout the region at the moment that will continue well into the night and if that was not enough we are going to have some very strong winds overnight to go with it. To see why, lets go over to the satellite. We are really surrounded by low pressure at the moment. This is the little centre that gave us the rain last night, now out into the North Sea. You can see there's still low pressure right down the western side of this country. But this is the little feature that we are worried about at the moment, its going to move very quickly northeastwards, up the country, right across the country during the course of the night out into the North Sea tomorrow morning bringing with it this great wedge of cloud and a lot more rain I am afraid. At the same time those winds coming from the south east initially and strengthening up to gale force and eventually going around southwesterly.

As far as this evening is concerned, well as I say, fairly grey, wet conditions over the whole county rain on more than off, some of that rain certainly on the heavy side. Fairly mild that is the only good news that I have got for you 9 or 10°C about 50°F. Those winds well southeasterly along the coast freshening right the way through as we go through the evening. The process continuing over night becoming strong to gale force particularly down the southeastern coastal region where it could be severe gales. Temperatures still well up 8 or 9°C but rain for a fair part of the night. It will be towards the end of the night. It will be towards the end of the night I think that drier weather gets up from the south as we go along and at the same time winds beginning to ease off just a little. Tomorrow morning well still quite windy perhaps a little bit of rain left in the extreme north, one or two showers breaking out as we go along. Those winds going southwesterly, decreasing a little bit further. By the afternoon well still quite a lot of dry and bright weather around, some showers too. The winds easing off all the time from the southwesterly direction and temperatures much as today. So summarising all of that a very stormy and wet night I think, with rain quite late on, showers and sunny spells tomorrow. Cheerio.

Annex 4.9(b) Local television forecasts, 'South Today', BBC South, 1850, 15 October 1987.

There are some very strong winds on the Sussex coast tonight. You can see there, southwesterly winds of gale force 8 quite easily, I think particularly along the Sussex coast, not quite as strong as that out to the west. But everywhere a wet night a wet evening probably, although the rain has become rather more drizzly for the time but it will pick up again and become heavy over night I think. Temperatures not low at all, down to around 13 or perhaps a little lower in the northwest there so a relatively mild night. Towards the end of the night clearer weather coming in to the west. Then tomorrow, well a brighter day certainly, some sunshine but still some heavy showers around. Temperatures only around 13 much like tonight. I think towards the end of the afternoon those showers could well become very heavy and quite widespread so not a pleasant day I'm afraid and again very strong southwesterly winds. So a pretty miserable day everywhere even in Sussex.

Annex 4.10 Selection of forecasts on Radio 4, local radio and Weathercall.

FPUK43 EGRB 151700
1755 RADIO 4 BROADCAST ON THURSDAY 15TH OCTOBER 1987 - NIGEL GAIT.

GOOD EVENING.

DEVELOPMENTS ARE TAKING PLACE RAPIDLY TO THE SOUTHWEST OF THE BRITISH ISLES AND IT NOW LOOKS AS IF AN INTENSE LOW PRESSURE CENTRE WILL MOVE NORTHEASTWARDS ACROSS THE MIDLANDS OVERNIGHT AND INTO THE NORTH SEA BY THE MORNING. THIS WILL BRING STRONG WINDS AND SOME WARMER AIR FOR A TIME INTO THE SOUTHEAST WITH THE RAIN AREA MOVING NORTH TO COVER MUCH OF BRITAIN DURING THE NIGHT.

I'LL START WITH SOUTHEAST ENGLAND AND EAST ANGLIA WHERE THERE WILL BE FURTHER OUTBREAKS OF RAIN OVERNIGHT, SOME OF IT HEAVY BUT CLEARER WEATHER WILL SPREAD QUICKLY FROM THE WEST LATER IN THE NIGHT. TEMPERATURES WILL RISE IN THE NEXT FEW HOURS TO AROUND 14 DEGREES BUT DROP BACK TO AROUND 8C BY DAWN. IT WILL ALSO BECOME QUITE WINDY WITH SOUTHERLY WINDS TOUCHING GALE FORCE NEAR SOUTHEASTERN COASTS FOR A WHILE. TOMORROW WILL BE A MUCH BRIGHTER DAY WITH SUNSHINE AT TIMES BUT ALSO SOME BLUSTERY SHOWERS. TOP TEMPERATURES AROUND 13C WITH A FRESH TO STRONG SOUTHWESTERLY WIND.

NOW ALL REMAINING WESTERN AND NORTHERN PARTS OF ENGLAND TOGETHER WITH WALES. RAIN WILL CONTINUE TO SPREAD NORTHWARDS THIS EVENING REACHING THE EXTREME NORTH OF ENGLAND BY MIDNIGHT, THE RAIN HEAVY AND PERSISTENT IN PLACES. CLEARER WEATHER WILL SPREAD QUICKLY FROM THE WEST IN THE EARLY HOURS BUT WITH SHOWERS FOLLOWING INTO WESTERN COASTS. LOWEST TEMPERATURES 7C. TOMORROW WILL BE A DAY OF SHOWERS AND SUNNY INTERVALS, THE SHOWERS HEAVY AND PROLONGED AT TIMES IN THE WEST BUT WITH SOME PARTS WITH SHELTER FROM HIGH GROUND TO THE WEST HAVING ONLY SCATTERED SHOWERS. TOP TEMPERATURES 11 TO 13 WITH A FRESH TO STRONG WEST TO SOUTHWEST WIND.

OVER MUCH OF SCOTLAND AND NORTHERN IRELAND IT'S BEEN A WET DAY, THE RAIN OVER CENTRAL SCOTLAND SOON MOVING INTO THE FAR NORTH THIS EVENING WITH SOUTHERN SCOTLAND AND NORTHERN IRELAND BECOMING MOSTLY DRY FOR A WHILE. LOWEST TEMPERATURES OVERNIGHT 6C (43F). TOMORROW WILL BE A RATHER CLOUDY DAY WITH SHOWERS OR SOME LONGER SPELLS OF RAIN ESPECIALLY IN THE NORTH AND WEST WITH EASTERN SCOTLAND HAVING ONLY A FEW SHOWERS AND SOME BRIGHTER SPELLS. BEST TEMPERATURES BETWEEN 8 AND 10C SO ANOTHER COLD DAY WITH WINDS STARTING MOSTLY A MODERATE NORTHWESTERLY BUT BACKING SOUTHWESTERLY AND BECOMING STRONG IN PLACES LATER.

ON SATURDAY THERE WILL BE A DRY SPELL IN MANY REGIONS BUT FURTHER RAIN WILL REACH THE WEST LATER IN THE DAY AND SPREAD TO MOST PARTS ON SUNDAY.

THAT'S THE FORECAST - BACK TO DAVID SIMONDS.

:975515
975515 BBCRNF G
975184 WEANOR G
15-OCT-87 16:45

ATTENTION: BELOW IS THE LATE ISSUE FORECAST TO BE USED THROUGHOUT EVENING. PLEASE USE AND PASS ON.

FORECAST FOR RADIO NORFOLK FOR THIS EVENING, TONIGHT AND TOMORROW. ISSUED BY THE NORWICH WEATHER CENTRE AT 1645 ON THURSDAY 15TH OCTOBER 1987.

PERIODS OF RAIN WILL CONTINUE ALL NIGHT BEFORE IT TURNS MORE SHOWERY TOWARDS THE END OF THE NIGHT. THE RAIN WILL BE HEAVY AT TIMES, POSSIBLY WITH THUNDER. WINDS WILL BE MODERATE TO FRESH EAST OR SOUTHEAST AT FIRST BUT WILL TURN SOUTHWESTERLY DURING THE NIGHT AND INCREASE STRONG TO GALE-FORCE. IT WILL BE A MILD NIGHT, THOUGH, MINIMUM TEMPERATURE DOWN TO 8 DEG CELSIUS (46F).

TOMORROW WILL SEE SOME SUNNY INTERVALS BUT THERE WILL BE SHOWERS DURING THE DAY, AND SOME OF THESE WILL TURN HEAVY AND PROLONGED. TEMPERATURES WILL REACH 13 DEG CELSIUS (55F) BUT IT WILL FEEL COLD IN A STRONG TO GALE FORCE SOUTHWESTERLY WIND WHICH WILL SLOWLY MODERATE DURING THE DAY.

975184 WEANOR Gx̲
975515 BBCRNF G

RADIO SUSSEX (issued 1642)

>FROM SOUTHAMPTON WEATHER CENTRE

>15TH OCTOBER 1987

>HERE IS THE FORECAST FOR TONIGHT AND TOMORROW

>OUTBREAKS OF RAIN, HEAVY IN PLACES, WILL CONTINUE THROUGH THE
>EVENING AND WELL INTO THE NIGHT WITH THE RATHER VARIABLE WINDS
>BECOMING STRONG SOUTH TO SOUTHWESTERLY, FORCE 5 TO 7 OVER MORE
>EXPOSED COASTS AND HILLS. IN SPITE OF THE WIND AND RAIN, IT WILL
>BE A MILD AND MISTY NIGHT WITH TEMPERATURES AROUND 13 DEGREE
>CELSIUS, HIGHER IN FACT THAN THIS AFTERNOON.

>THE MORE PERSISTENT RAIN WILL HAVE CLEARED MOST PARTS BY THE
>MORNING, AND TOMORROW WILL BE A DAY OF SUNNY SPELLS AND SHOWERS,
>THOUGH SOME OF THE SHOWERS ARE EXPECTED TO BE HEAVY. WINDS WILL
>REMAIN FRESH OR STRONG SOUTHWESTERLY, FORCE 5 OR 6 OVER THE WATER,
>AND TEMPERATURES WILL REACH A MAXIMUM OF ABOUT 14 DEGREES CELSIUS.

>THE OUTLOOK FOR SATURDAY

>BRIGHTER WITH SOME SUNNY INTERVALS AND SCATTERED SHOWERS.

>SUMMARY: WET AND WINDY TONIGHT WITH BLUSTERY SHOWERS TOMORROW,
>TEMPERATURES NEAR 13 DEGREES CELSIUS FOR MUCH OF THE TIME.
>NNNN

TO: TIS
FROM: NORWICH WEATHER CENTRE
PERIOD OF FORECAST: 6 PM ON THURSDAY UNTIL 6 PM ON FRIDAY
DATE OF ISSUE: THURSDAY 15TH OCTOBER 1987

WEATHERCALL FORECAST CAMBRIDGE, NORFOLK AND SUFFOLK (AREA 8).

THE EVENING AND NIGHT WILL BE STORMY WITH THE PERIODS OF RAIN CURRENTLY OVER THE REGION CONTINUING THROUGHOUT THE NIGHT. LATER IN THE NIGHT TOWARDS THE MORNING SOME DRIER WEATHER IS LIKELY TO SPREAD FROM THE SOUTHWEST, BUT THERE ARE STILL LIKELY TO BE SHOWERS IN THIS DRIER WEATHER. THE RAIN TONIGHT WILL BE HEAVY AT TIMES AND MAY BE ACCOMPANIED BY THUNDER. WINDS WILL BE FRESH EAST OR SOUTHEAST FOR A TIME BUT WILL INCREASE TONIGHT TO STRONG OR GALE FORCE AS IT SLOWLY VEERS TO THE SOUTHWEST. IT WILL BE A MILD NIGHT, THOUGH, TEMPERATURES FALLING TO NO LOWER THAN 8 DEG CELSIUS.

TOMORROW THERE WILL BE SUNNY INTERVALS DURING THE MORNING AND AFTERNOON BUT SHOWERS WILL DEVELOP THROUHOUT THE DAY, THESE TURNING HEAVY AND PROLONGED ON OCCASIONS ESPECIALLY IN THE AFTERNOON. THE SOUTHWEST WINDS WILL STRONG OR GALE FORCE AT FIRST BUT WILL SLOLWLY MODERATE AS THE DAY GOES BY BUT IN THESE WINDS IT WILL FEEL COLD AS TEMPERATURES CLIMB TO AN AFTERNOON MAXIMUM OF 13 DEG CELSIUS.

THE OUTLOOK UNTIL 6 PM ON SATURDAY

THE SHOWERS WILL MOSTLY DIE OUT FRIDAY NIGHT TO GIVE LONG CLEAR SPELLS. SATURDAY WILL BE A MOSTLY DRY DAY WITH A FAIR AMOUNT OF SUNSHINE WITH THE WINDS MODERATING STILL MORE.

THE ATMOSPHERIC PRESSURE AT 5 PM AT IPSWICH WAS 979 MILLIBARS.

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>FROM SOUTHAMPTON WEATHER CENTRE

>15TH OCTOBER 87

>THE FORECAST FOR AREA 3
>DORSET, HAMPSHIRE, AND THE ISLE OF WIGHT, UNTIL 6PM TOMORROW

>ALL PARTS OF THE REGION WILL HAVE A WET AND WINDY EVENING AND NIGHT

>WITH SOME OF THE RAIN BECOMING HEAVY IN PLACES. WINDS, RATHER

>VARIABLE AT FIRST, WILL BECOME FRESH TO STRONG SOUTHWESTERLY DURING

>THE EVENING BRINGING MIST AND FOG PATCHES TO MANY COASTS AND HILLS.

>IN SPITE OF THE WIND AND RAIN, IT WILL BE A MILD NIGHT WITH

>TEMPERTAURES AROUND 13 DEGREES CELSIUS, HIGHER IN FACT THAN THEY

>HAVE REACHED DURING THE DAYTIME.



>THE MORE PERSISTENT RAIN WILL HAVE CLEARED BEFORE MORNING AND

>TOMORROW WILL BE A DAY OF SUNNY SPELLS AND SHOWERS, THOUGH THE

>SHOWERS WILL BE WIDESPREAD DURING THE AFTERNOON AND QUITE HEAVY IN

>PLACES. TEMPERATURES WILL CHANGE LITTLE, PERHAPS REACHING 14

>DEGREES CELSIUS AT BEST. WINDS WILL BE MOSTLY FROM THE SOUTHWEST

>AND FRESH OR STRONG ESPECIALLY ALONG THE MORE EXPOSED COASTS OF

>DORSET AND THE ISLE OF WIGHT.



>THE OUTLOOK FOR FRIDAY NIGHT AND SATURDAY:

>SHOWERS WILL CONTINUE WELL INTO FRIDAY EVENING, BUT THEY SHOULD BE
>MUCH MORE SCATTERED ON SATURDAY WITH MOST PLACES HAVING SOME SUNNY
>INTERVALS AND THE FRESH TO STRONG SOUTHWEST WINDS WILL MODERATE.


>THE PRESSURE READ AT SOUTHAMPTON AT 5PM TODAY WAS 975 MILLIBARS.
>NNNN
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ZCZC
TO TIS FOR WEATHERCALL - AREA 2 - KENT, SURREY & SUSSEX FORECAST
FROM LONDON WEATHER CENTRE FILE REF:R10
(C)CROWN COPYRIGHT 1986. ALL RIGHTS RESERVED.

ISSUED AT 1700 ON THURSDAY 15TH OCTOBER 1987.

HERE IS THE FORECAST FOR KENT, SURREY & SUSSEX UNTIL DUSK TOMORROW

THE RAIN ALREADY INTO ALL PARTS OF KENT, SURREY AND SUSSEX WILL CONTINUE THROUGHOUT THE EVENING AND WELL INTO THE EARLY HOURS OF FRIDAY. THE RAIN WILL BECOME HEAVY AT TIMES, ESPECIALLY ON HIGH GROUND.

DURING THE EVENING THE WARM AIR WHICH IS PARTLY RESPONSIBLE FOR ALL THIS RAIN WILL CROSS THE AREA AND THE TEMPERATURE WILL RISE TO AROUND 13 DEGREES CELSIUS FOR A SHORT TIME.
AFTER THE RAIN DIES OUT, SOME CLEAR SPELLS WILL DEVELOP, ALLOWING THE TEMPERATURE TO FALL TO 7 OR 8 DEGREES CELSIUS. WHICH IS AROUND NORMAL FOR MID AUTUMN.
DURING TOMORROW MORNING THERE WILL BE SOME SUNSHINE, BUT CLOUD WILL SOON DEVELOP, GIVING ONE OR TWO SHOWERS DURING THE COURSE OF THE DAY. THE SHOWERS_SHOULD BE FAIRLY WIDESPREAD THOUGH AND SOME PLACES MAY BE LUCKY AND GET AWAY WITH A DRY DAY.
IT WILL BE ANOTHER RATHER COOL DAY, WITH THE TOP TEMPERATURES ONLY GETTING UP TO 13 OR 14 DEGREES CELSIUS, AND PERHAPS NOT EVEN AS HIGH AS THAT WHERE THE SHOWERS ARE MORE FREQUENT.
THE WIND TOMORROW WILL BE A BIT STRONGER, ESPECIALLY ALONG THE SUSSEX AND KENT COASTS, AND INTO THE CHANNEL, BEING SOUTHWESTERLY STRONG, OCCASIONALLY VERY STRONG.

THE OUTLOOK FOR THE EARLY WEEKEND ISN'T TOO BAD, WITH SOME SUNSHINE ON SATURDAY AND THE TEMPERATURE CREEPING UP A COUPLE OF DEGREES ON TODAYS MAXIMUM. THERE WILL, HOWEVER, STILL BE THE CHANCE OF THE ODD SHOWER OR TWO.

THE PRESSURE, CORRECTED TO SEA LEVEL, AT GATWICK AIRPORT AT 5PM ON WAS 977 MILLIBARS FALLING.

NNNN

Annex 4.11 'National Summary', Radio 4, 0020, 16 October 1987.

And the Meteorological Office issued the following gale warning to shipping .... it seems to be just about all the sea areas. Martin Rowley is at the London Weather Centre, how are things going to be for us on dry land Martin?

It's not going to be much better on - I was going to say 'dry land' - it's not very dry at the moment is it. Yes and the pressure is very low again, the lowest pressure just now 963 mb, that's 28.4 inches. In fact the barometer is still falling quite rapidly in the southwest of Britain. Here at London Weather Centre we've beaten our October record barometer reading, 973 mb, it just reinforces the obvious dominance that low pressure, thick cloud and rain has had on the United Kingdom weather this October, especially in southern Britain. Northern Ireland had faired reasonably well, at least up to today, with not too much rain, but there was quite a lot of rain around this morning and that only cleared slowly during the day and afternoon temperatures only struggled up to 6 or 7 across the Province, and that's the same as their normal night temperature so it really was a cold day. Scotland experienced rain that had pushed north across the border from England and Wales earlier yesterday night, some pretty heavy rain in southern Scotland, though central and northern areas, after a frosty night in places, had a reasonably bright morning, and then the rain arrived during the afternoon. Over northern England and North Wales a lot of rain in the morning, the weather tending to turn brighter and drier from the south and that allowed Manchester to become the sunniest spot, mind you, a pretty poor apology for sunshine with just over 2 hours. Central and southern England and South Wales, well in for quite a bashing. A dry and bright start to the day, some weak and watery sunshine, but thickening cloud brought rain to many south coastal areas of England before lunchtime and then it was just a case of waiting for the bottom to fall out of the pressure pattern, the rain to really set in, some heavy and prolonged rain moving in to the Midlands, east Anglia and southern parts of Wales, again causing flooding problems in Kent and Sussex, where they have already had twice their normal October rainfall, some places down there three times the normal rainfall.

Now tonight, just to re-emphasise, some dirty, wet weather to come, especially for England and Wales, as a really nasty depression sweeps up from Biscay and the rain moving to southern and eastern Scotland by dawn. So some really unpleasant conditions if you are out and about on the roads and motorways tonight, some torrential rain, stormy winds eventually, especially on the Channel coast, and there will be inland gales as well. On Friday there will still be some of that heavy rain left in parts of northern England and Scotland at dawn, then it will move away and the whole country will be in a rather windy, showery airflow, some of the showers turning out to be heavy and prolonged, especially in western and southern coastal regions. Now some sheltered spots in the east of England and eastern Scotland may escape with few showers but you will need to get rid of the morning rain first, and although some places will see a little sunshine, in the wind, especially in places with persistent blustery bursts of showery rain, it will feel decidedly cold, indeed over some northern hills sleet and snow is likely.

Over the weekend remaining very unsettled, there will be further showers, indeed during Saturday more prolonged rainfall reaching the west and north and then moving to other areas through Sunday, but it may allow some eastern parts of England to have not too bad a day on Saturday anyway. Monday and Tuesday no real break, there will be more rain crossing from west to east, but some eastern areas again, particularly on Monday, may have a reasonably fine and pleasant day.

Well I think that's enough from the Weather Centre just now, from me I'll wish you a very peaceful night.

Annex 4.12 'Weatherview', BBC 2, 2305, 15 October 1987 (recorded 2030).

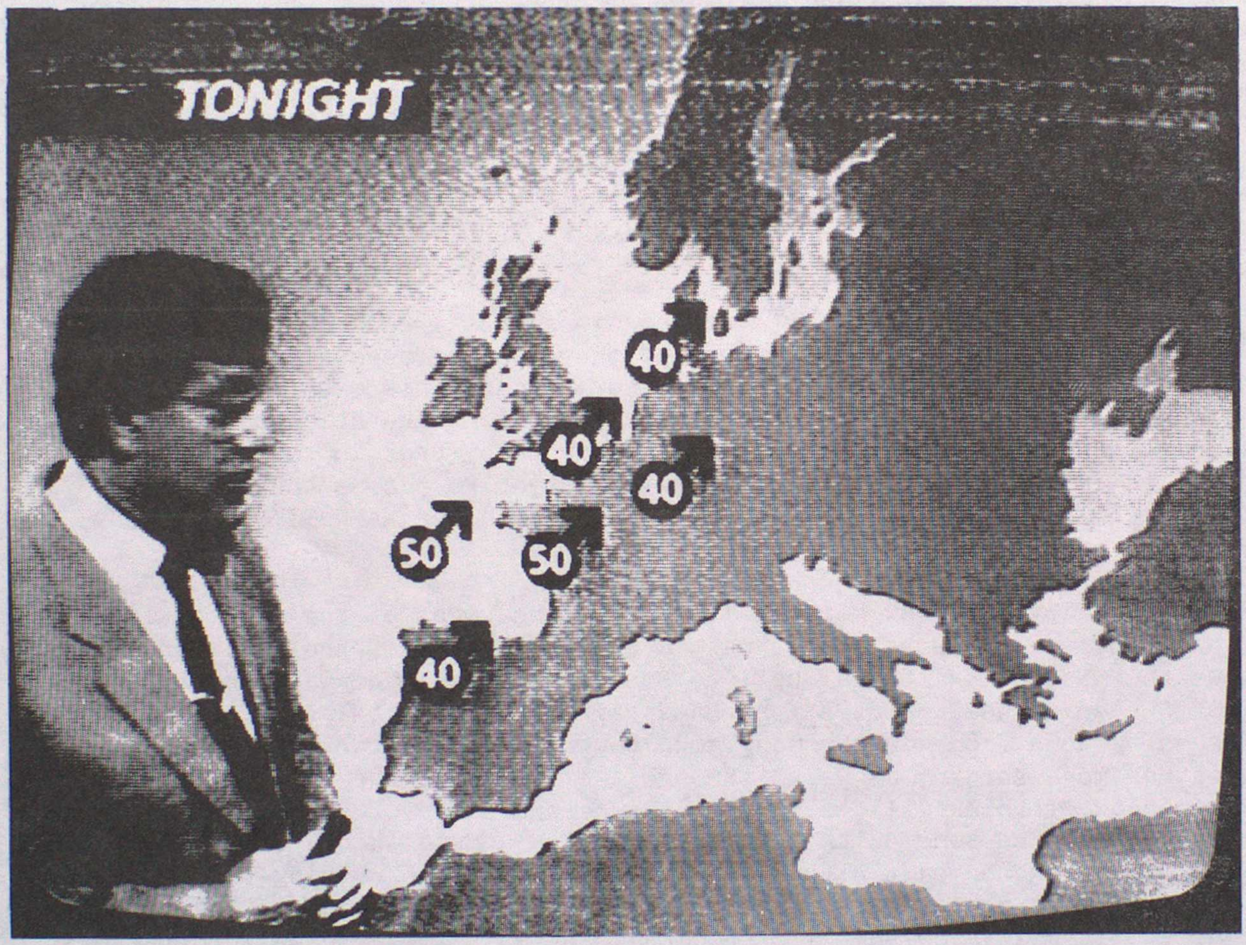
Good evening to you, well it has turned out to be another miserable day in many places. We have had a great band of rain, heavy rain at that, coming into southern parts of England, getting up into the Midlands this evening and up into Wales too and yet another band of wet weather over southern Scotland gradually edging its way northwards. The satellite picture shows all. This is what it was seeing in the early hours of this morning, the white areas are the cloud remember, you can see that swirling its way up from the south. And it is this frontal system here with this band of cloud which has been giving the wet weather up in northern parts. It is not just rain that we have been getting off this we have been getting some pretty strong winds too.

Well that is what the situation was like earlier on this evening it is associated with this quite deep low pressure area and a few days ago we thought it would be coming a little further west bringing the strong winds right across the country. But now it looks as though most of those strong winds will stay away although it is still going to be very breezy up through the Channel and on the eastern side of the country. Well that's what the rainfall picture looked like earlier on and you can see through tonight that rain continuing to work its way north and then out into the North Sea and then we will be getting a fair number of showers pushing their way, in particular on the western and southern side of the country during tomorrow. Let's look at Europe first of all and as I have already said it is not just rain, its strong winds that are going with it too. Winds of 50/60 miles an hour pushing their way up across northern parts of France in across Holland, up in towards Denmark this evening and then through tomorrow they are going to continue to work their way up across into Scandinavia so if you are off to Europe by boat in the next day or two you're in for a pretty rough trip even if you go across the North Sea, through the Channel or indeed across the Irish Sea as well. Some very choppy crossings indeed.

Well by tomorrow morning I think the heaviest of the rain could well have got up into Scotland across into many parts of Scandinavia and clearer weather following its way up into southern parts of Norway, southern parts of Sweden as well. But at the same time there will be a band of rain running down from west Germany down towards central parts of Spain turning rather more showery as we go through the day. But the worst of the showers tomorrow, I think will be over north western parts of France in particular. There could be some quite heavy ones dotted around there. And then a band of cloud further east with the best of the sunshine running down through the Mediterranean, so if you are off to the Mediterranean in the next day or two it really doesn't look too bad particularly if go well to the east where there is a good deal of sunshine dotted around. There are quite high temperatures down there as you can see still but pretty cold further north.

Well that's what Europe looks let's get in a little bit closer and see the weather over this country. Well this band of rain is continuing to work its way north some of the rain turning out to be fairly heavy, and then getting up into Scotland but much of clearing away I think into the

North Sea by the end of the night and not a particularly cold night. In fact down here in the south it is still a very humid feel to it and quite windy as well. Tomorrow morning, still dull and wet I think in northern parts particularly over central and northern parts of Scotland, quite bright elsewhere. There will be some sunshine around but showers will soon be coming along I think particularly down through southern counties of England, particularly near the English Channel, a fair number of showers dotted around there and then although there could be some showers almost anywhere tomorrow I think as I say most of them in the west and in the south. Temperatures very much the same as they have been today still quite breezy though in the east. That's it. Goodbye.



Annex 4.13 Instructions for issuing FLASH weather messages.

FLASH Weather Messages

1. General Concepts

1.1 FLASH messages give public warning of the occurrence or strong likelihood of severe weather which may cause considerable inconvenience to a large number of people and/or present a danger to life. There are six types of FLASH message namely those for dense fog, heavy rain, heavy snow, glazed frost or widespread icy roads, severe gales inland and blizzards or severe drifting.

1.2 When FLASH messages are issued there must be a high degree of confidence. Often this will be based on actual weather observations and local knowledge, making use of all reliable sources of information including AA/RAC, Police etc. In certain situations it may be possible to predict confidently the occurrence of severe weather, and a FLASH message may be issued within about 3 hours of the expected onset of the severe weather.

1.3 The essence of the scheme is speed. Rapid dissemination to the public is achieved by means of radio and television broadcasts; whenever possible, messages are inserted as interruptions during programmes, but when this is not acceptable they are sent out at the first programme junction after receipt.

1.4 FLASH messages can be issued at any time during the 24 hours and have considerably more impact than routine forecasts or warnings. This will however only remain true if the number of messages is kept within reasonable bounds; detailed criteria for issue have therefore been drawn up for each type of FLASH message.

If the severe weather persists within an area for several hours a REPEAT FLASH message may be issued. This woudl be sensible if, for example, the original FLASH was issued overnight and the severe weather was still affecting rush-hour traffic.

1.5 FLASH messages referring to the 18 major urban areas of the UK having populations exceeding 250 000 are broadcast nationally. The offices responsible for these are listed in Annex A.

FLASH messages may, in exceptional circumstances, be issued for other areas that have a significant population density, when severe weather is expected to be limited to that area. Offices responsible for road danger warnings should originate FLASH messages in such cases.

1.6 Blizzard/severe drifting FLASH messages may refer to any area, lowland or upland, urban or rural, and are also broadcast nationally. Offices responsible for Road Danger Warnings are also responsible for issue of blizzard FLASH messages for the same areas: in addition to the offices listed in Annex A, those listed in Annex B should originate these messages for their areas of responsibility.

1.7 Although it is primarily the responsibility of the originating offices to initiate FLASH messages, the Senior Forecaster at CFO holds a watching brief over the operation of the scheme; duty forecasters at originating offices may consult him if they wish before issuing a message, and he will initiate discussion with them if he thinks an issue is overdue.

1.8 ALL FLASH messages for national dissemination will be passed to London Weather Centre for onward transmission to BBC Radio and Television. The Senior Forecaster at LWC, in consultation with CFO, acts in a coordinating role and when necessary will initiate action to prepare composite messages.

1.9 FLASH messages referring to smaller urban areas may also be issued to local radio stations; responsibilities for these stations are noted in Annexes A and B.

2. Responsibilities of originating offices

2.1 The 18 major urban areas in the UK with populations exceeding 250 000 are listed below:

Greater London
West Midlands
Greater Manchester
West Yorks
Merseyside
South Yorks
Tyne and Wear
Glasgow
South Wales
East Midlands
Edinburgh
Bristol
Southampton/Portsmouth
Potteries
Belfast
Teesside
Humberside
Plymouth

The offices responsible for the issue of FLASH messages for these areas are indicated in Annex A.

2.2 With the exceptions given in paras 1.5 and 1.6, a FLASH message for national broadcast will only be issued when the criteria detailed in para 3 are met for one or more of the above urban areas. However, if it is considered inappropriate to restrict the area of application of the message to the major urban area alone, the text may indicate that the message applies to a clearly defined, wider region which, except in the case of composite messages (see para 6.3), must include the appropriate major urban area in its description. When doing this, care must be taken not to overlap without discussion into areas for which other offices have a forecasting responsibility for BBC VHF Regional radio (where applicable) Radio Scotland, Radio Wales, ITV or local radio (BBC and IBA) as indicated in Annexes A and B. In all cases of doubt, there should be discussion with the other offices concerned before the text of the FLASH message is finalized.

2.3 FLASH messages for blizzards are in a special category and should be issued when the criterion in para 3.7 is met for any area including rural and upland regions. Originating offices are those having a responsibility for Road Danger Warnings, and there may well be overlap problems, especially for the stations listed in Annex A; consultation in these cases will be essential.

2.4 Offices listed in Annexes A and B as having a responsibility for local radio stations (BBC and IBA) should contact those stations to determine whether or not they wish to receive:

a. any FLASH message issued nationally for repetition in local broadcasts;

and b. special locally originated FLASH messages applying to towns within their service area.

Suitable arrangements for free issue will then be made locally. Where it is impractical for a responsible office to deal directly with a particular local radio station, with Met O 7a agreement the task may be delegated to another office over which it has technical parentage.

2.5 Originating offices which are M Met Os act independently when issuing a FLASH message, but may consult the Senior Forecaster at CFO if desired. Originating offices which are not M Met Os should consult the senior forecaster at the parent office in the normal way; but as speed of issue is so important to the success of the FLASH scheme, such offices are authorized to act independently if contacting the parent office before issue would introduce significant delay.

3. Criteria for issue of FLASH messages

3.1 As FLASH messages have more impact than routine forecasts and warnings, and are issued only when there is high confidence, in most cases based on actual observations. The fact that the weather concerned was mentioned in an earlier forecast is no reason for withholding a FLASH. The over-riding criterion for the issue of a FLASH message is the occurrence or strong likelihood of severe weather which may cause considerable inconvenience to a large number of people and/or present a danger to life. The detailed criteria set out below are intended to give guidance concerning the severity of weather likely to meet the over-riding criterion; they are not inflexible rules.

3.2 Dense fog: Visibility generally less than 50 metres. A FLASH message should be issued to mark the onset of these conditions. In prolonged dense fog REPEAT FLASH messages should be used sparingly; a significant change (e.g. a temperature fall that leads to freezing fog) should be the subject of a new FLASH message.

3.3 Heavy rain: A FLASH message should be issued when a period of mostly heavy rain is expected to persist for at least 2 hours from the time of onset such that a total of 15 mm or more falls within three hours. Particular attention should be paid to the need for a FLASH message for heavy reain when soil moisture deficits are zero or nearly so, since the risk of flooding is then increased. In no circumstances should the word "flooding" be used in the text.

3.4 Heavy snow: Snow falling and accumulating at a rate of at least 2 cm per hour; this approximates to the mid-point of moderate snow and upwards. A FLASH message should be issued when such snow is expected to persist for at least 2 hours. The message should mention drifting if this is expected to be a significant factor. If the snow persists for a longer period a REPEAT FLASH message should be considered.

3.5 Glazed frost and/or widespread icy roads: The occurrence of glazed frost caused by freezing rain or drizzle is rare in urban areas of the UK; when it does happen there will be widespread ice on untreated roads, and a FLASH message should be issued. Icy roads can also arise from other sources (e.g. hoar frost or rime), but FLASH messages should only be issued when roads are known to be icy over a wide area or area confidently expected to become so. The icy surface that sometimes develops on snow covered roads does not normally warrant a FLASH message unless the onset of the icy conditions is associated with a first covering of snow.

3.6 Severe gales inland: A FLASH message should be issued when over an inland area the mean wind increases to at least 40 knots or gusts exceed 60 knots. The alternative gust criterion is important, as it is often the repeated occurrence of high gusts that cause structural damage and consequently a danger to life. Care should be taken not to be over-influenced by observations from exposed coastal or hill sites, which may well not be representative of the main urban areas.

3.7 Blizzards or Severe Drifting: (in urban or rural areas): The onset over a wide area of a blizzard or severe blizzard as defined in Annex B to Chapter 4 of Met O 868 should be accompanied by the issue of FLASH message. On occasions when no snow is falling a FLASH message of Severe Drifting should be issued when the combination of lying snow and strong winds (at least Force 7) is expected to give rise to similar conditions. The intention here is primarily to give warning of the sort of conditions that occurred in the West Country in early 1978 and caused widespread disruption of transport and food supplies and loss of livestock, the amount of drifting being of major importance. This type of blizzard in a lowland area is a rare event and there should be little difficulty in identifying such cases which require the issue of a FLASH. But it is also hoped that the issue of blizzard FLASH messages for upland areas may help to minimise large-scale losses of livestock and also prevent fatalities among parties who may ill-advisedly set out for the hills. There is clearly a danger that too many messages for upland areas may be issued, and commonsense must be applied. Originating forecasters should pay attention particularly to those areas where there are known to be very large holdings of livestock or which are visited regularly by organized parties, and should look for those occasions when the defined blizzard conditions are confidently expected to occur over a wide area.

3.8 In exceptional circumstances a FLASH message may be issued for an area of significant population density which is not one of the 18 major urban areas. For example a FLASH message should be considered for east Kent if heavy snow is falling in that area, but not in Greater London. In order to keep the number of FLASH messages to a minimum, this criterion should be used only rarely, when conditions are unusually severe.

4. Form of FLASH messages

4.1 Texts must be written in a form and style that will carry maximum impact, and all messages must commence with the preamble:

"Here is a FLASH message of severe weather in (area affected)" (REPEAT)*

* If appropriate.

The body of the text will then indicate the type of weather causing concern, the period it is expected to last and the area affected.

4.2 In many cases, emphasis can be added to the message by making reference to actual weather reports and to the type of inconvenience or danger envisaged. In the case of severe gales, the text should indicate the expected maximum gust speed in miles per hour and must include the phrase "some structural damage may occur".

4.3 Examples (omitting preamble):

a. Dense fog has been reported from many parts of Glasgow with visibilities as low as 20 metres. The fog is expected to persist in and around the City until at least mid-morning.

b. Heavy rain has been falling over Merseyside and Greater Manchester and over much of Lancashire and Cheshire for several hours; it is expected to continue throughout the night.

c. Heavy snow now falling over Sussex and Kent is expected to reach the Greater London area shortly and continue for 3 to 6 hours. There will be some drifting of the snow and driving conditions will become very hazardous.

d. Many roads in the East Midlands will become very icy as rain falls and temperatures remain below freezing. Driving conditions will become very hazardous.

e. Winds are expected to increase to severe gale force in the Edinburgh area within the next hour or so and will remain at this level until this evening. Gusts up to 70 or 80 miles per hour are likely and some structural damage may occur.

f. Blizzard conditions with heavy snow and gale force winds are expected to develop widely in Southwest and Central Southern England by midday. There will be extensive drifting and conditions are likely to remain exceptionally severe this afternoon.

5. Procedures at Originating Stations

5.1 As soon as the duty forecaster at an originating office decides to issue a FLASH message, he will telephone London Weather Centre using tie-lines to MOD Main Building Ext 6904 or British Telecom lines to 01- - as appropriate. The latter number is ex-Directory and must not be divulged to third parties.

5.2 An originating office will also pass the message:

a. to ITV Companies for which it is responsible (see Annexes A and B);

b. when appropriate to local radio stations for which it is responsible (see Annexes A and B);

c. when a blizzard FLASH refers to a BBC Regional, ITV or local radio service area for which the originating office is not itself responsible, to the office which has this responsibility;

d. to any other originating office which has an urgent need for such messages and has made an arrangement with the originating office to receive them directly in this way.

5.3 Offices which have agreed with local radio stations to initiate FLASH messages for towns other than those listed in 2.1 will pass such messages to those stations.

5.4 All originating stations should deal promptly with any telephone request from another originating office for discussion concerning FLASH issues; in particular, London Weather Centre may have to make such requests as part of its coordinating role or to obtain background information for a national BBC broadcast.

5.5 Requests received by originating offices from local radio stations for recorded telephone or live interviews concerning FLASH issues and the weather situation which has led to them should be met whenever possible; offices which are not M Met Os must consult their parent office for briefing, but HQ permission for broadcasts of this type is not needed.

5.6 Originating offices must keep full records of FLASH issues including times of despatch to each recipient.

6. Procedures at LWC and CFO

6.1 All FLASH messages received at LWC and those originated locally will be recorded in a special book and will be shown at once to the Senior Forecaster. Except in the special circumstances described in para 6.2 below, he will authorize immediate despatch by the fastest possible means to:

a. BBC Newsroom for Radio 2;
b. BBC Radio 4 Continuity for Radios 1, 3 and 4;
c. BBC Television (Weatherman when on duty otherwise Presentation);
d. CFO;
e. MCC Bracknell, addressed "PRIORITY FOR MCCA. COPY TO CFO, DS MET O, MET O 7A AND MET O 23"

6.2 In certain weather situations, there is a danger of proliferation of FLASH messages and this both reduces the impact and is most unwelcome to the BBC. When a FLASH message arrives, the Senior Forecaster at LWC should consider the possibility of this happening, and if he thinks it likely he should delay the issue and at once discuss the matter on the telephone with the Senior Forecaster at Bracknell.

6.3 If after discussion it is decided that a composite message covering several areas is desirable, the LWC Senior Forecaster will discuss the situation with duty forecasters at relevant originating offices and prepare a suitable text. In certain circumstances it may be more convenient for the CFO Senior Forecaster to carry out this liaison by means of a Special SR. In the case of composite messages, the area description need not refer to those major urban areas within it. FLASH messages refer to severe weather conditions which are actually occurring or are confidently expected to commence within 3 hours. Composite texts should not take the form of a forecast covering a large area with times of onset outside these limits. Instead, separate, but coordinated FLASH messages should be issued at intervals.

6.4 If, as a result of the issue of a FLASH message, the BBC ask LWC to make a recorded or live broadcast about the current weather situation this should be done whenever possible; specific HQ authority is not needed, but the radio or television weatherman may need to telephone other originating offices for up-to-the-minute information before making the broadcasts.

ANNEX A

Responsibilities for FLASH messages for major urban areas

Originating Office	Major urban area	BBC National & Regional Radio	ITV	BBC Local Radio	IBA Local Radio
Cardiff Weather Centre	South Wales	Radio Wales/Cymru	HTV Wales		CBC (Cardiff) Swansea Sound
London Weather Centre	Greater London	Radio 1 & 2	Thames London Weekend	London Medway Oxford	LBC) (London) Capital) 210 (Reading) Chiltern (Luton) Eastway (Chelmsford) East Kent County Sound (Guildford)
Bristol Weather Centre	Bristol		HTV West	Bristol *Taunton	West (Bristol) Severn Sound (Gloucester)
Glasgow Weather Centre	Glasgow Edinburgh	Radio Scotland VHF Highland	Scottish		Clyde (Glasgow) West Sound (Ayr) Forth (Edinburgh)
Manchester Weather Centre	Greater Manchester Merseyside Potteries		Granada	Clwyd Manchester Merseyside Stoke Lancashire	Piccadilly (Manchester) City (Liverpool) *Wrexham/Deeside *Preston/Blackpool

Responsibilities for FLASH messages for major urban areas (Cont)

Originating Office	Major urban area	BBC National & Regional Radio	ITV	BBC Local Radio	IBA Local Radio
Newcastle Weather Centre	Tyne & Wear Teeside		Tyne Tees	Newcastle Carlisle Cleveland Furness	Metro (Newcastle) Tees (Stockton)
Nottingham Weather Centre	East Midlands		Central (East)	Derby Nottingham Leicester Lincolnshire Northampton	Trent (Nottingham)
Southampton Weather Centre	Portsmouth/ Southampton		TV South (currently not accepting FLASH)	Sussex Solent	Victory (Portsmouth) Two Counties (Bournemouth) Southern Sound
Aldergrove	Belfast	Radio Ulster	Ulster	Foyle	Downtown (Belfast) *Londonderry
Birmingham Airport	West Midlands		Central	Birmingham	BRMB (Birmingham) Beacon (Wolverhampton) Mercia Sound (Coventry) Wyvern (Worcester)

Responsibilities for FLASH messages for major urban areas (Cont)

Originating Office	Major urban area	BBC National & Regional Radio	ITV	BBC Local Radio	IBA Local Radio
Leeds Weather Centre	South Yorks West Yorks Industrial Humberside		Yorkshire	Leeds Sheffield Humberside York	Pennine (Bradford) Hallam (Sheffield) Aire (Leeds) *Barnsley
Plymouth	Plymouth	VHF Southwest	TV South West	Devon Cornwall	Plymouth Sound Devonair (Exeter)

* Planned stations

ANNEX B

Responsibility for BLIZZARD/SEVERE DRIFTING FLASH messages

All stations in Annex B have responsibility for BLIZZARD/SEVERE DRIFTING messages, also the undermentioned stations:

Originating Office	BBC National and Regional Radio	ITV	BBC Local Radio	IBA Local Radio	
Aberdeen	VHF Orkney VHF Shetland VHF Aberdeen	Grampian		Northsound Moray Firth Tay	(Aberdeen) (Inverness) (Dundee)
Norwich Weather Centre		Anglia	Norfolk Cambridgeshire	Orwell Hereward Saxon	(Ipswich) (Peterborough) (Bury St Edmunds)

* Planned Stations

Annex 4.14 Warning message (land) issued 15/16 October 1987.

WARNINGS

1. British Rail
   Overhead line warning issued 15/1730
   Area affected - Romford
   'Commencing 2300 on 15/10/87 for 8 hours'
   Sent by document facsimile
   (Note: this covers N.E of London, much of Essex, Suffolk and Norfolk)

2. London Fire Brigade
   Strong wind warning issued 15/2150
   'Winds expected to gust to over 30mph until further notice'
   Sent by telex

3. East Anglian Police Forces
   Suffolk, Norfolk and Cambs Police (and BBC HQ for Motoring Unit)
   Warning of overland strong winds issued 15/2305
   'The wind will continue to veer south to south west over all parts of the region and mean force 6 to gale force 8 during the remainder of the night and Friday morning. Winds may reach severe gale force 9 at times along exposed parts of the coast'.
   Sent by telex

4. BBC Motoring Unit
   Issued 16/0015
   'Gale force winds will affect many roads in south east England over night with driving rain at times. Gusts in excess of 50mph are expected in many areas, especially Essex and Kent'.
   Sent by telex

5. FLASH Weather Message
   Issued 16/0120
   'Severe Weather Flash. here is a FLASH message of severe weather in England and Wales. Severe gale force winds already affecting southern districts will spread northwards across many parts of England and Wales before morning. Gusts in excess of 70mph are expected and some structural damage may occur'.
   Sent by telex

6. MOD
Issued 16/0135
'Warning of severe weather conditions which may call for military aid to the civil community. Severe inland gales with gusts in excessof 70mph now occurring over southern England are expected to spread northwards overnight. Some structural damage may be expected. Also heavy rain over Wales and the Midlands is expected to persist for some hours and spread steadily northwards'.
Sent by telex

7. London Fire Brigade
Issued 16/0140
Warned of exceptionally severe conditions for the rest of the night with winds 70-80 mph. Conditions are likely to make it a 'night to remember'
Issued by telephone

8. Police Forces in South-east
Thames Valley, Metropolitan, Essex, Kent, Herts, Beds, Surrey Police Forces, issued 16/0145
'Although rain is still falling across the area, and is expected to continue for some while, the main weather hazard is now winds, with southerly storm force winds gusting at least to 70 mph and perhaps even stronger before some moderation may be expected later. Therefore all forces should expect several hours of wild and stormy conditions across the south east of England'.

Annex 4.15 Gale and storm warnings (for shipping) issued 15/16 October 1987.

ZCZC
PP PH4

RE: WWUK
.67541
WWUK50 EGRR 150630

Warnings issued from 1800 GMT yesterday to 0630 GMT today.

CFO warnings Nos: 29*2255) 30 (0410)

CFO upper wind warning Nos: 97 (0400)

Summary of gale warnings now in operation.

Sea areas: Viking North Utsire South Utsire Forties Cromarty Forth Tyne Dogger Fisher German Bight Humber Thames Dover Wight Portland Plymouth Biscay Trafalgar Finisterre Bailey Fair Isle and Southeast Iceland.

NNNN

CFO GALE WARNING THURSDAY 15 OCTOBER 1030 GMT NO. 31

DOVER

Gale force 8 backing southeasterly and increasing severe gale force 9 soon.

WIGHT

Gales force 8 backing southeasterly and increasing severe gales force 9 imminent.

PORTLAND

Gale force 8 backing easterly and increasing severe gale force 9 imminent.

PLYMOUTH

Gale force 8 backing northerly soon.

CFO GALE WARNING THURSDAY 15 OCTOBER 1710 GMT NO. 33

DOVER AND WIGHT

Severe gale force 9 veering southerly imminent.

PORTLAND

Severe gale force 9 backing southwesterly and decreasing gale force 8 soon.

PLYMOUTH

Gale force 8 backing northwest soon.

CFO GALE WARNING THURSDAY 15 OCTOBER 2235 GMT NO. 34

....

DOVER, WIGHT

Severe gale force 9 veering southwesterly and increasing storm force 10 imminent.

PORTLAND

Southwesterly severe gale force 9 increasing storm force 10 imminent.

PLYMOUTH

Gale force 8 backing southwesterly and increasing storm force 10 imminent.

CFO GALE WARNING FRIDAY 16 OCTOBER 0135 GMT NO. 36

....

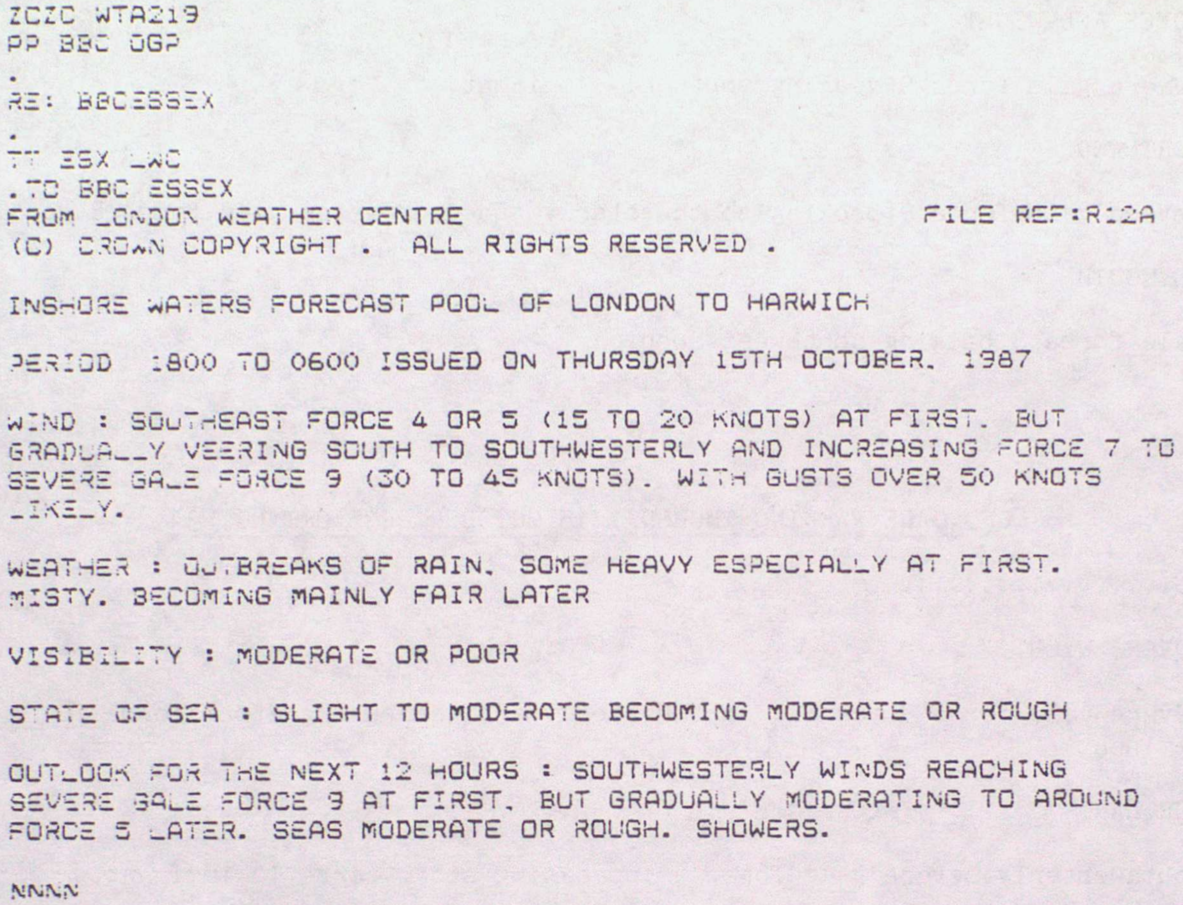
DOVER, WIGHT, PORTLAND

Southwesterly storm force 10 increasing violent storm 11 imminent.

PLYMOUTH

Storm force 10 veering westerly and increasing violent storm 11 imminent.

Annex 4.16 'Inshore waters forecast', Radio Essex, 1800, 15 October 1987.



```
ZCZC WTA219
PP BBC OGP
.
RE: BBCESSEX
.
TT ESX LWC
.TO BBC ESSEX
FROM LONDON WEATHER CENTRE                              FILE REF:R12A
(C) CROWN COPYRIGHT .  ALL RIGHTS RESERVED .

INSHORE WATERS FORECAST POOL OF LONDON TO HARWICH

PERIOD  1800 TO 0600 ISSUED ON THURSDAY 15TH OCTOBER. 1987

WIND : SOUTHEAST FORCE 4 OR 5 (15 TO 20 KNOTS) AT FIRST. BUT
GRADUALLY VEERING SOUTH TO SOUTHWESTERLY AND INCREASING FORCE 7 TO
SEVERE GALE FORCE 9 (30 TO 45 KNOTS). WITH GUSTS OVER 50 KNOTS
LIKELY.

WEATHER : OUTBREAKS OF RAIN. SOME HEAVY ESPECIALLY AT FIRST.
MISTY. BECOMING MAINLY FAIR LATER

VISIBILITY : MODERATE OR POOR

STATE OF SEA : SLIGHT TO MODERATE BECOMING MODERATE OR ROUGH

OUTLOOK FOR THE NEXT 12 HOURS : SOUTHWESTERLY WINDS REACHING
SEVERE GALE FORCE 9 AT FIRST. BUT GRADUALLY MODERATING TO AROUND
FORCE 5 LATER. SEAS MODERATE OR ROUGH. SHOWERS.

NNNN
```

Annex 4.17 Offshore forecasts for an oil company.

FORECAST FOR UK BLOCK 49/12

SYNOPTIC SITUATION AT 0300 GMT ON MONDAY 12/10/87
PRESSURE WILL REMAIN LOW TO THE NORTHWEST OF SCOTLAND AND A SUCCESSION OF WEAK TROUGHS AND MINOR LOWS WILL SWING NORTHEASTWARDS ACROSS THE BRITISH ISLES AND SURROUNDING SEA AREAS DURING THE NEXT THREE DAYS OR SO. HOWEVER, IN MID-WEEK A FAST MOVING ATLANTIC LOW IS EXPECTED TO DEVELOP EXPLOSIVELY AS IT NEARS THE BRITISH ISLES. STORM FORCE WINDS ARE LIKELY FROM THIS FEATURE OVER THE NORTH SEA LATER IN THE WEEK, WITH THE STRONGEST WINDS LIKELY IN THE SOUTH. (IT IS PRUDENT TO SAY THAT THIS FEATURE DOES NOT EXIST AS YET AND SO ITS STRENGTH AND COURSE WILL BE SUBJECT TO UPPER ATMOSPHERIC DEVELOPMENTS IN THE MEANTIME)

FORECAST FOR UK BLOCK 49/12

SYNOPTIC SITUATION AT 1200 GMT ON MONDAY 12/10/87
A DEPRESSION WILL REMAIN SLOW MOVING TO THE NORTHWEST OF SCOTLAND WITH TROUGHS CROSSING THE COUNTRY AND NORTH SEA DURING TODAY AND TOMORROW. ON THURSDAY A LOW WILL MOVE QUICKLY EAST ACROSS THE ATLANTIC AND DEEPEN AS IT APPROACHES THE UK. THIS WILL BECOME A MAJOR FEATURE AS IT CROSSES THE COUNTRY ON FRIDAY AND WILL BRING SEVERE GALES TO MANY PARTS OF THE NORTHSEA. ON LATER ON FRIDAY THE LOW WILL TRANSFER INTO THE NORWEGIAN SEA WITH WINDS SLOWLY DECREASING AGAIN IN THE SOUTH.

FORECAST FOR UK BLOCK 49/12

SYNOPTIC SITUATION AT 0001 GMT ON TUESDAY 13/10/87
DEEP LOW TO THE WEST OF SCOTLAND WILL CONTINUE TO DOMINATE THE WEATHER FOR THE NEXT FEW DAYS. MINOR TROUGHS WILL INCREASE SHOWERY ACTIVITY AND WIND FROM TIME TO TIME. BY THURSDAY ANOTHER LOW WILL BE DEEPENING OVER THE SOUTHWEST APPROACHES TO BRITAIN AND BEGINNING TO TURN NORTH. OVER FRIDAY AND SATURDAY THE (BY NOW INTENSE) LOW WILL MOVE NORTH TO SHETLAND WITH WINDS LIKLEY TO REACH SEVERE GALE OR PERHAPS EVEN STORM FORCE LATER AS HEAVY RAIN TURNS TO BLUSTERY SHOWERS.

FORECAST FOR UK BLOCK 49/12

SYNOPTIC SITUATION AT 1200 GMT ON TUESDAY 13/10/87
A DEPRESSION TO THE WEST OF SCOTLAND WILL REMAIN SLOW MOVING BUT WITH TROUGH CIRCULATING AROUND IT AND CROSSING THE UK AND NORTH SEA FROM TIME TO TIME. DURING THURSDAY A DEEPENING LOW WILL MOVE INTO BRITAIN FROM THE SOUTHWEST. BECOMING A MAJOR FEATURE AND BRINGING A PERIOD OF SEVERE GALES TO MANY PARTS OF THE NORTH SEA. THE LOW WILL THEN TURN NORTH OVER THE NORTHERN NORTH SEA AND IS EXPECTED TO BE IN THE NORWEGIAN SEA ON SATURDAY WHERE IT WILL BEGIN TO SLOWLY FILL.

GALE WARNINGS: NIL IN OPERATION FOR YOUR AREA AT TIME OF ISSUE OF THIS FORECAST

REMARKS: THE DEVELOPMENT OF THE MAJOR LOW IS PRESENTING SOME PROBLEMS AND ALTHOUGH WINDS OF FORCE 9 ARE HIGHLY LIKELY IN YOUR AREA THE EXACT TIMING IS UNCERTAIN.

FORECAST FOR UK BLOCK 49/12

SYNOPTIC SITUATION AT 0001 GMT ON WEDNESDAY 14/10/87
LOW TO THE WEST OF SCOTLAND WILL DRIFT SLOWLY NORTHWEST AS A SMALL WAVE LOW AND TROUGH SWINGS NORTH OVER THE NORTH SEA DURING TONIGHT AHEAD OF A DEVELOPING INTENSE LOW. THIS IS EXPECTED TO TURN NORTHEAST TOWARDS SOUTHWEST ENGLAND BY MIDDAY THURSDAY.OFF THE TYNE BY MIDNIGHT. AND THEN NORTH TO JUST NORTH OF SHETLAND BY MIDDAY FRIDAY. ''''AS PREVIOUSLY INDICATED SEVERE GALES OR EVEN STORM FORCE WINDS ARE EXPECTED AROUND THE LOW AND PARTICULARLY FOR A TIME LATER IN THE SOUTHWESTERLIES OVER THE NORTH SEA TO THE SOUTH OF THE CENTRE LATE THURSDAY/FRIDAY.
DURING SATURDAY THE WINDS WILL STEADILY MODERATE AND THE NEXT LOW, ALTHOUGH DEEPENING AS IT TURNS NORTH, IS EXPECTED TO BE MUCH LESS INTENSE AND MUCH FURTHER WEST, PROBABLY PASSING CLOSE TO THE WEST COAST OF IRELAND ON SUNDAY WITH CONSEQUENTLY LIGHTER WINDS OVER THE NORTH SEA.

FORECAST FOR UK BLOCK 49/12

SYNOPTIC SITUATION AT 1500 GMT ON WEDNESDAY 14/10/87
THE LOW TO THE NORTHWEST OF SCOTLAND IS SLOW MOVING AND WILL DECAY SLOWLY DURING THE NEXT THREE DAYS. A DEVELOPING LOW AND ITS ASSOCIATED TROUGHS ARE NOW OVER SOUTHWEST BRITAIN AND WILL SWING NORTHEASTWARDS ACROSS THE NORTH SEA TONIGHT AND TOMORROW. HOWEVER. ANOTHER LOW IS DEVELOPING IN MID-ATLANTIC.AND WILL DEVELOP FURTHER AS IT APPROACHES THE SOUTH OF BRITAIN TOMORROW EVENING. THE EXACT TRACK IS A LITTLE UNCERTAIN AT PRESENT BUT WE EXPECT THE CENTRE TO MOVE QUICKLY NORTHEASTWARDS ACROSS SOUTHEAST BRITAIN AND THE SOUTHERN NORTH SEA.AND INTO NORWAY,DURING THE COURSE OF FRIDAY. A FURTHER LOW WILL FOLLOW ON MONDAY.

GALE WARNINGS. GALE FORCE 8 IN OPERATION FOR SEA AREA HUMBER

REMARKS: THE EXACT TRACK OF THE LOW TOMORROW EVENING WILL BE CRITICAL TO THE WINDS AND WAVES EXPERIENCED IN YOUR AREA ON FRIDAY. THE SITUATION IS BEING CAREFULLY WATCHED AND YOU WILL BE SENT UPDATES IF NECESSARY OF COURSE

FORECAST FOR UK BLOCK 49/12

SYNOPTIC SITUATION AT 0001 GMT ON THURSDAY 15/10/87
LOWS OVER NORTHWEST ENGLAND AND OVER YOUR LOCATION MOVING NORTH AND MERGING - REACHING THE ORKNEYS BY MIDNIGHT TONIGHT.
AT THIS TIME A FURTHER LOW - PRESENTLY OVER BISCAY - WILL BE CROSSING THE SOUTHERN NORTH SEA HEADING TOWARDS NORWAY. THEREAFTER A SHOWERY SOUTHWESTERLY AIRSTREAM WILL AFFECT YOUR LOCATION UNTIL THE ARRIVAL OF FRONTAL TROUGHS ON SUNDAY

GALE WARNINGS: SEVERE GALE FORCE 9 IN OPERATION FOR SEA AREA HUMBER

FORECAST FOR UK BLOCK 49/12

SYNOPTIC SITUATION AT 1200 GMT ON THURSDAY 15/10/87
A VIGOROUS LOW PRESENTLY NEAR THE BREST PENINSULA WILL INITIALLY MOVE QUICKLY NORTHEAST ACROSS SOUTHEAST BRITAIN. BEFORE BECOMING RATHER MORE SLOW-MOVING IN THE CENTRAL NORTH SEA BY TOMORROW MORNING. THIS WILL BRING A SPELL OF VERY STRONG WINDS TO YOUR LOCATION DURING THE FIRST TWO FORECAST PERIODS. WHILE THE ASSOCIATED FRONTS BRING PERIODS OF HEAVY RAIN FOR A TIME. THE LOW WILL CONTINUE TO MOVE NORTHEAST TOWARDS THE NORWEGIAN SEA. WITH A FRESH SOUTHWESTERLY FLOW MAINTAINED ACROSS THE SOUTHERN NORTH SEA DURING SATURDAY.
ANOTHER LOW IS EXPECTED TO MOVE TOWARDS WESTERN BRITAIN ON SUNDAY

GALE WARNINGS: SEVERE GALE FORCE 9 IN OPERATION FOR SEA AREA HUMBER

REMARKS: THE EXACT TRACK OF THE LOW IS A LITTLE UNCERTAIN. BUT IT IS EXPECTED TO STAY TO WELL TO THE WEST OF YOUR LOCATION. WITH THE STRONGEST WINDS FROM BETWEEN SOUTH AND SOUTHWEST.

FORECAST FOR UK BLOCK 49/12

VICIOUS LOW NOW JUST SOUTH OF CORNWALL TRACKING NORTHEAST ACROSS SOUTHERN ENGLAND OVERNIGHT EXPECTED TO PASS CLOSE TO YOUR LOCATION WITHIN THE NEXT 4-6 HOURS - RESULTING IN STORM FORCE OR POSSIBLY VIOLENT STORM FORCE FOR A TIME. WINDS AHEAD OF THE LOW WILL BE SOUTHERLY VEERING NORTH OF WEST FOR A TIME TO ITS REAR BEFORE BACKING SOUTHWEST AND EASING LATER IN THE NIGHT. NOTE ANY SUDDEN MARKED DROP IN WINDSTRENGTH IS LIKELY TO BE VERY SHORTLIVED - CLOSE TO THE LOW CENTRE.

GALE WARNINGS: STORM FORCE 10 IN OPERATION FOR SEA AREA HUMBER - LIKELY TO BE UPRATED TO 11

REMARKS: PLEASE NOTE OUR TELEPHONE NUMBER BELOW IF YOU REQUIRE ANY ADVICE DURING TONIGHT.
NEXT ROUTINE FORECAST WILL BE DESPATCHED TO YOU AROUND 0615GMT

(issued 0130 16 October 1987)

Annex 4.18 'Goodyear Weather Forecast', Superchannel, 1355 GMT, 15 October 1987.

MICHAEL FISH

Good afternoon to you.

It's a case of batten down the hatches I think for some parts of Europe; some very, very stormy weather on the way indeed. On the satellite picture you can see that there is a lot of cloud around over most parts of Europe as well, so the weather obviously not only windy but unsettled, with a fair bit of rain.

so let's have a look at the chart that goes with it. There's a vicious area of low pressure at the moment heading towards Brittany and as you can see, a lot of isobars running in across most central parts of Europe, indicating that the weather is going to be windy. Now let's have a look at those isobars and the area of low pressure, which you can see under the shading there, and the shading of course shows us where the heaviest rain is going to be. And as I run the sequence you can see that area of low pressure, a nasty one at that, runs up towards Scandinavia and takes most of the rain with it, although there is some left even tomorrow through the more middle parts of Europe.

So the detail now. Well obviously, as we've just seen, a lot of rain around. That applies to the southeast of Britain, much of Scandinavia and Germany, France, the Low Countries, even down to Spain and Portugal, and in places some of that rain could be quite heavy. Northern and western parts of Britain and northern Scandinavia are somewhat brighter, with some sunshine, but not necessarily dry because there will be showers around.

Now heading back to Spain, I think most of the heaviest of the rain will miss the well known resorts in the south and east, and in the Balearics, but it certainly will be quite cloudy and you might actually even get one or two spots of rain. Northern Italy a little bit on the cloudy side, the sunshine there fairly hazy, but eastern Europe and towards the Black Sea and the Soviet Union some sunshine, and apart from the odd shower, generally speaking fairly dry. The best of the weather though certainly the toe of Italy, North Africa, Greece and Turkey, where there should be a lot of sunshine.

Now the main feature about today, as I said at the beginning, is that it is going to be very windy indeed, in fact in Spain and Portugal and France and pushing in to the Low Countries there will be gales I think before the day is out and it's going to be pretty windy in many areas as well, the winds pushing their way as time goes on up towards Scandinavia.

Now here's a representative look at the temperatures around Europe this afternoon, and as you can see, in Roma and Lisbon despite the rain in Lisbon it will be reasonably warm, but most other parts if anything I think on the cool side, although not necessarily as cool as they have been.

As for tonight, still unsettled and windy in many areas with further rain but the Mediterranean lands fine and dry.

that's all for now - a very good afternoon to you.

Annex 4.19 Forecast from the French Weather Service, issued 14 October 1987.

ZCZC
NSXX45 LEPW 141030
repetition of message number 5046 of October 14 1987

origin: French National Weather Service

destinations: all Met. offices , other places including
French railways, Water Board (Ministry of Enviroment)
National Press, French electricity board, TV stations

Special meteorlogical bulletin forecasting storm force winds over France between the evening of Wednesday October 14 to daytime on Friday October 16.

The meteorlogical situation will become more severe after today, Wednesday, during the evening and then the following night - with the passage of a cold front which has associated rain and strong winds over the North-East of France, the Vendee, Poitou-Charentes, the Paris basin and the North. In these regions the winds will be temporarily ‘violent’, with mean speeds of 60-70 km/hr and gusts reaching 100 km/hr are probable.

Tomorrow (Thursday), after a temporary calm, a new storm storm which is stronger than its predecessor will arrive at the Atlantic coast. This situation is generated by the arrival over Europe from the West of a powerful depression system which will favour frequent spells of rain and, above all, an acceleration of the winds oriented in the southern sector where the strength will reach storm force.

So we forecast for Thursday morning average winds of order 80 to 100 km/hr over the Aquitaine and Vendeennes coast, then during the day over the Brittany coast and the channel. The extreme gusts could reach and exceed 150 km/hr in coastal regions.

Inland, where the regime of strong winds will be established during the day, the winds will be less violent but very strong. We forecast a mean speed of 70 to 80 km/hr with gusts exceeding 100km/hr over Aquitaine, the Massive Central and the North-east of the country. The strongest winds will probably be North of the Loire, over Brittany, North-east and the North as far as the Ardennes. There is still a risk of strong winds affecting France on Friday 16, with the winds not slackening until the second half of the day.

End of Special Met. bulletin

Annex 4.20 Gale warnings for 15/16 October issued by the French Weather Service.

BMS MARINE LARGE number 19 replacing number 18

origin: PREVI/MAR BMSLARGE

October 15 1987 0630 UTC

Warning of severe gales, beginning in the South over Sole, Channel West, West Brittany, North Gascony, South Ireland building up to storm force overnight.

General situation 00 UTC October 15, and forecast.

Depression 985 hPa just North-west of the Corogne moving to the Channel arriving by the end of the day.

A second depression 990 hPa centred at 43 N 23 W moving towards the Channel, reaching it tonight, then towards the North Sea tomorrow. It steers a very strong South-west flow in the evening and that night over the near Atlantic and the Channel.

- For West Channel, West Brittany, North Gascony and Sole:

valid between October 15 at 12 UTC and October 16 at 06 UTC

Wind South-east to South-west 30/40 kt (force 7/8 Beaufort) freshening 35/45 kt (force 8/9 Beaufort) from South-west overnight.

- For South Ireland:

valid between October 15 at 18 UTC and October 16 at 06 UTC

Wind North-east 30/40 kt (force 7/8 Beaufort).

BMS MARINE LARGE number 20   replacing number 19

origin: PREVI/MAR   BMSLARGE

October 15 1987 2020 UTC

Warning of storm to violent storm force winds over Sole, Channel West, West Brittany, North Gascony.

General situation 18 UTC October 15, and forecast.

Depression 960 hPa just North-west of the Corogne steering to the Channel, arriving in the middle of the night.

- cancellation of storm warning for South Ireland.
- For West Channel, West Brittany, North Gascony and Sole:

valid until October 16 at 06 UTC

Wind South-west 45/60 kt (force 9 to 11 Beaufort) decreasing 40/45 kt (force 8/9 Beaufort) in the second half of the night.

BMS MARINE LARGE number 21   replacing number 20

origin: PREVI/MAR   BMSLARGE

October 16 1987 0300 UTC

Warning of storm force winds over Sole, Channel West, West Brittany North Gascony:.

General situation 00 UTC October 16, and forecast.

Depression 955 hPa just North-west Brittany moving towards the North Sea.

- For West Channel, West Brittany, North Gascony and Sole:

valid until October 16 at 08 UTC

Wind South-west 40/50 kt (force 8/10 Beaufort) decreasing 40/45 kt (force 8/9 Beaufort) by the end of the night.

Chapter 5

MEDIA REACTION

5.1 Introduction

During the period following the storm, there was an unprecedented level of interest from TV, radio and the Press, most of it centred on the question 'Why did the forecasters get it wrong?', though there were many subsidiary issues. The majority of items were critical of the Office, some extremely so, but about a quarter provided a more or less balanced view of the situation. As time progressed there was a growing body of Press opinion (though never in the majority) which expressed a more sympathetic view. An increasing proportion recognized that the south-east of England could not have escaped the damage, however accurate the forecasts might have been. Many letters were received from members of the public; the vast majority expressed support for the Meteorological Office in the face of what was perceived as undue criticism in the Press.

5.2 Survey of reports and interviews

A survey has been conducted to ascertain the reactions of the Media both before and after the storm. A major source of data for the survey was the set of press articles extracted routinely from the national daily and Sunday newspapers. Weather Centres in the south of England have supplied copies of items that have come to their attention in the other national and local papers. The other major source of data has been a series of transcripts of radio and TV programmes, supplied by an agency.

Every item available has been examined, but it must be stressed that there are gaps in the coverage — notably many of the local papers and the Daily Mirror. It is also rather unlikely that no comments on the subject were included in any of the weekend radio or TV programmes, as stated by the agency. However it is felt that, given the repetitive nature of much reportage, the points mentioned are likely to be a good representation of most of those made even in the areas not examined in the survey.

5.3 Summary of reactions of the Media

The following summary outlines the reactions of TV, radio and the Press, and the main issues highlighted.

(i) *Before the storm*

During the weekend prior to the storm, much media attention had been given to the widespread flooding which had occurred in the south-east of England following a period of very heavy rainfall. Reports of 'torrential rain' were quoted, and photographs of flood damage appeared under front-page headlines in many national newspapers on Monday 12 October. Meteorological Office spokespersons were quoted as saying that the worst of the rain had passed. There were no reports recorded in the Media concerning the gales forecast for the end of the week.

(ii) *Friday 16 October*

By daybreak on Friday 16 October, the majority of TV and radio services were in chaos. Breakfast-time television and radio was disrupted, with only skeleton services being transmitted. These transmissions almost exclusively reported facts as they became available, together with warnings and guidance for householders, travellers, schoolchildren, etc.

As the morning progressed, services were re-established, and attention began to shift towards forecasts issued the previous day. At 11 a.m. Nigel Gait of London Weather Centre was being faced on the Jimmy Young Programme (BBC Radio 2) with such statements as 'I don't recall being told in advance to expect weather like this'.

During the day, radio and TV picked up many of the issues that were to be expanded and reiterated later:

- An assertion that the ambulance services did not receive a warning.
- An assertion that the London Fire Brigade was paying for a warnings service.
- A comment by Michael Fish on his BBC TV Lunch-time Forecast that there wouldn't be a hurricane. Subsequently, this term was used in virtually all Media reports and articles to describe the event. (Note that, whereas hurricane force winds were observed, the weather system did not have the structure of a hurricane, and was not classified as such. Formal explanations of these terms are given in Annex 5.1)
- Bill Giles' BBC 2 presentation pre-recorded at 2030 and broadcast at closedown on the 15th in which, pointing to tight isobars with 50 m.p.h., said 'it will be very breezy up through the Channel and on the eastern side of the country'. (Note that this comment was followed by a description of very strong winds to be expected. A transcript is given in Annex 4.12 to chapter 4. Subsequent viewing of the transmission makes it clear that this was intended to be conveyed as a deliberate understatement.)
- The opinion that the Meteorological Office and the weathermen might be sued for negligence. This was particularly highlighted in the BBC Radio 4 Programme 'PM' at 5 p.m.
- Opinions that the warnings came 'too late, no effective warning.'
- The view that meteorology needs more upper-air stations and weather ships.
- The view that the Office was only as good as its forecasts of extreme events.

(iii) *Saturday 17 October*

The Saturday papers were emblazoned with reports concerning the storm. The typical front page headline was something like 'Why weren't we warned?' The Times printed a report that the Meteorological Office had disregarded information from ECMWF, and that the French and Dutch had got the forecast right. This point was subsequently taken up by many newspapers as a key issue.

(iv) *Sunday 18 October*

By now, many newspapers were seeking stories which concentrated on the personalities involved. The Director-General of the Meteorological Office and the TV weathermen — notably Michael Fish — were besieged at their homes by reporters and cameramen. In addition, the BBC TV Centre was inundated with press enquiries concerning the weather and the forecasts broadcast prior to the storm.

The Sunday Telegraph reported the Environment Secretary as condemning an 'unbelievable failure to get it right'. Most papers concentrated on the French/Dutch/ECMWF forecasts. There was a complaint from one private meteorological consultant that the distribution of ECMWF forecasts were unfairly controlled by the Office, and a statement from another that he used forecasts from the Office, ECMWF and Offenbach!

(v) *Monday 19 October*

Monday's papers produced a number of new points:

- A virulent attack on the Cyber supercomputer (Guardian).
- The possibility of privatization (Telegraph).
- The view that power officials 'could have coped if we'd been warned' (Telegraph).
- Bengtsson's (ECMWF) comments: '(the Met Office) trying to be too exact' (Telegraph).
- The Sun called for the Director-General's resignation. Reports of interviews with the Director-General in the Mail and Financial Times tempered the acidity a little.

The evening TV and radio carried reports and reactions to the Director-General's News Conference, the views of ITN's News at Ten being particularly condemnatory despite broadcasting an interview with the Director-General. The whole issue was trivialized in the TVS Question programme ('Weathermen always forecast for the part of the country you're not interested in').

(vi) *Tuesday 20 October*

On Tuesday 20th most of the papers gave full accounts of the Director-General's Press Conference, some with later interviews, and the whole tone was very considerably changed for the better, although the Guardian still talked of the Office as 'top of everyone's list of duffers'. The evening TV and radio were also by this time coming down to a very low key, with most references being to the setting up of an Enquiry. In the course of the Tuesday Call Programme (BBC Radio 4) the head of the Dutch Company, Meteocast, agreed that reports that they had forecast with greater precision were misleading. A transcript of this broadcast is given in Annex 5.2.

(vii) *Wednesday 21 October*

On Wednesday the papers produced a variety of views. The Express had some irate language — 'complete, shameful devastation of the credibility of those smugly useless TV weather people', and most papers reported details of the Swinnerton-Dyer/Pearce inquiry, but the real interest lay in the letters. These ranged from the first mention of 'What could we have done even if the forecast HAD been correct?' to 'Do without them!'. There was a more supportive air generally, with letters from Brian Hoskins and Ian James (Department of Meteorology, Reading University) suggesting probabilistic forecasting, and Norman Lynagh (Noble Denton Weather Service) saying that it could not have been forecast in detail more than a few hours before. His letter, however, went on to ask why the warnings had not been issued until after midnight. Several other letters backed probabilistic forecasting, usually by suggesting the use of 'may', 'could', 'might', etc. as well as 'will'.

Media interest was revived at this stage as severe flooding occurred in South Wales and the South of England. Merton Council was reported as complaining of the Meteorological Office's supposed inadequate warnings, to be rebutted by an interview with Roger Hunt (London Weather Centre) on Thames TV News later in the day. There was a fair amount of further TV coverage, mainly on ITV. During the morning Norman Lynagh was interviewed on the Jimmy Young Programme (BBC Radio 2).

(viii) *Thursday 22 October*

In Thursday's papers there were fewer articles but more interest. John Gribbin in the Mail blamed it all on the greenhouse effect, Arthur Blackham in the Independent celebrated 'dead silence from the frog-spawn watchers' and recommended the Noble Denton Weather Service method of giving confidence levels. An article in The Sun was headed 'Twenty things you didn't know about Weather Wally Fish'.

Professor Pearce in the Breakfast Time interview was fair but neutral despite rather leading questions from the interviewer. In the evening Tomorrow's World produced an 'explanation' of the forecast failure based on a theory that the 0.2°C global rise over the last ten years had been greater over the oceans than the land.

(ix) *Friday 23 October*

In Friday's Telegraph an article concluded that if it were not for the Ministry of Defence the Office could be the next to be privatized and rationalized. The other papers only carried letters of interest, among which were one from Hugh Cumming (IPCS spokesman) and another demanding more weather ships, a comment that was to be repeated fairly often. There was little on TV.

(x) *Saturday 24 October and after*

On Saturday 24th the Times Third Leader was asking why the Office should be in the Ministry of Defence, suggesting that the Office was being asked to do too much, highlighting conflict between the Office's role as a National Meteorological Office and its commercial roles, and that we penalized the airlines in comparison with the shippers.

The Sunday Times went back through all the early comments without adding anything significant.

Tuesday's Guardian carried a blatant advertisement in the guise of an article about Meteocast (Europe's satellite-TV weather channel) saying that it was better than the BBC forecasts or teletext because it was continually updated.

On Friday 30th it was discovered that BBC's CEEFAX had been carrying a highly critical article entitled 'MEGA-BLOOMER' for a period of at least a week (see Annex 5.3).

On Saturday 31st an article by Brian Hoskins and Ian James (Department of Meteorology, Reading University) appeared in the Guardian, giving some very good background and making more clearly than anyone else the point that a 300 km wide storm can easily be missed by an upper-air observing network that has an average spacing of 270 km only over the land.

Thereafter the issue dropped out of the limelight, in the wake of continuing problems in the Stock Market.

A selection of Press reports is given in Annex 5.4.

5.4 Interviews, News Releases and Press Conferences

Many interviews were given by members of staff to the media. It has not been possible to identify all of these for local TV and Radio, but the key interviews which were broadcast nationally are listed in Annex 5.5.

During the period, two News Releases were issued by the Press Office:

(a) Friday 16 October at 3 p.m. issued from Bracknell. This gave a very brief summary of the key facts known at the time.

(b) Saturday 17 October at 3 p.m. issued from London Weather Centre. This concerned responsibility for Meteorological Office public service forecasts, and also stated that an internal inquiry on the storm was to be held.

Transcripts of the News releases are given in Annex 5.6.

On Monday 19 October, a Press Conference was held at London Weather Centre at 5 p.m., with the Director-General and senior members of the Directorate in attendance. A report of the Press Conference was circulated on Tuesday 21 October to all stations, together with the guidance that all press enquiries should continue to be routed through the Press Office. A copy of the report is given in Annex 5.7.

5.5 Reactions of the general public and customers

Not surprisingly, there was a considerable volume (several hundred) of letters and telephone calls from members of the public, as well as a smaller number from customers and representatives of various organizations.

The overwhelming majority expressed support for the Office and appreciation of its services. Many correspondents believed that the Office had been unduly criticized by the Press. Examples of letters are provided in Annex 5.8.

Among the commercial customers, there has been hardly any negative reaction. Two customers for medium-range forecasts complained about the failure to predict the intensity of the storm although, as stated earlier, the forecasts issued a few days before the event were in fact very good. The situation has been explained to them. The Office also received a complaint from the BBC who said that the lack of warning of the storm given in the television forecasts reflected upon their own credibility.

5.6 Summary of principal issues in the Media

Many comments and criticisms appeared in the Media, notably in the Press. There was a mixture of informed and uniformed opinion, as well as perceptions which in retrospect seem distorted. The central issues, most of which have been addressed elsewhere in this report, were:

- Whether the forecasts had been 'wrong'. This issue has been dealt with elsewhere in this report.

- Whether other meteorological agencies — particularly those in Holland and France — had issued more accurate forecasts. At present, no meteorological agency is claiming this — indeed there have been public assertions by such agencies to the contrary.
- Whether there had been any negligence, and whether any information (e.g. from ECMWF) had been disregarded.
- The comments made during TV forecasts during the previous day. The interpretation of these comments is a matter for judgement. Clearly, they were intended to be part of the style of delivery of the forecasts, aimed at making them more interesting rather than a dry repetition of the facts.
- Whether warnings had been too late.
- Whether emergency services had been given adequate warning.
- Whether commercial customers had received a better service than the General Public.
- Whether there are sufficient upper-air stations and weather ships.
- Whether the Meteorological Office should be privatized.
- Whether anything could have been done had there been more warning.
- The difficulties of forecasting such extreme events and weather system of such small size.

List of Annexes

Annex 5.1	The meaning of the term 'hurricane'.
Annex 5.2	Transcript of parts of Tuesday Call, Radio 4, 20 October 1987.
Annex 5.3	Article entitled 'MEGA-BLOOMER' on CEEFAX.
Annex 5.4	Selection of press reports.
Annex 5.5	Radio and TV interviews with members of staff.
Annex 5.6	News Releases issued by the Press Office.
Annex 5.7	Report on the Press Conference held on 19 October 1987.
Annex 5.8	Examples of letters received by the Meteorological Office from members of the public.

Annex 5.1 The meaning of the term 'hurricane'.

THE MEANING OF THE TERM "HURRICANE"

Hurricane: A name (of Spanish or Portugese origin) applied to the intense TROPICAL CYCLONES which occur in the West Indies and Gulf of Mexico regions and off the Queensland coast. They are essentially of the same type as the western Pacific 'typhoon' and Bay of Bengal 'cyclone'.

In the BEAUFORT SCALE of wind force the name "hurricane force"is given to a surface wind of force 12, corresponding to a mean speed of 64 knots or more. Mean speeds of this magnitude are very rarely attained in the British Isles, but the speed is frequently exceeded in gusts.

Source : Meteorological Office, *Meteorological Glossary*.
London :Her Majesty's Stationery Office: 1972

Annex 5.2 Transcript of parts of Tuesday Call, Radio 4, 20 October 1987.

Rough transcript of some of the points made in the programme
(P Presenter, DH David Houghton, DM Dutch meteorologist)

Several callers had made comments about the forecasts - not all unfavourable. One caller from Cockfosters had mentioned his barograph trace and the presenter then turned to David Houghton: How come you didn't get it? I am being very careful in picking my language but how come you didn't get it right?

DH We were very well aware that the barometer was falling and indeed gale warnings were up for the whole of the Channel from early in the week and severe gale warnings went up for all of the Channel areas on the Thursday morning but this particularly severe storm did not show its hand until towards midnight on the Thursday and it was not until just after midnight that warnings of severe weather, particularly severe weather for the land were sent to those who normally receive these warnings.

P But forecasters surely shouldn't wait until storms show their hand the whole point of forecasting is to that you forecast what the hand is going to be before it is played.

DH That is right, and in the normal course of events the normal storms are very well predicted. This was an extraordinary storm, it was not a normal storm it was one that developed extremely rapidly in the early hours of Thursday of -- the late hours of Thursday evening and the early hours of Friday morning and, er ehm, and no we didn't predict any significant time in advance the severity of that storm.

P .... aside to the caller who said the enormous respect for the forecasters and the presenter then tried to imply that his barograph was better than anything we had in the office.

P Since we had a call from Belgium we have put a call out to the Netherlands to a met called Harry O... who was much quoted in the papers especially the Observer as having forecasted what was going to happen in Britain and having warned his listeners not to travel to southern Britain - Harry good morning.

P Is it true that you were able to predict this storm so accurately.

DM Well I was on a radio broadcast on Wednesday morning on Radio Veronica and I did point out that the models showed both the European Centre for Medium Range Weather model, that is the computer model of the European Weather Centre, and also the Bracknell model were giving hints that one way or another that one of the lows that was coming towards us would explode and would bring violent gales. At that point though, and I told the Observer as well, we thought that it would be more the S and SW of England and the Channel and not so much the SE part of England, but indeed I predicted force 12 and gusts up to 90 knots.

P Ah so in fact it is a bit misleading that you forecast with greater precision what was going to happen. You weren't able to say that these winds would sweep with hurricane force across much of S Britain; you were only able to say that there would only be serious storms probably in the Channel

DM Yes, there would be serious storms in the Channel and in S England but it was very hard to tell at that point where exactly the low would come and where it would explode but then in the course of THursday afternoon you could see very clearly that something terrible was happening you could see it on the satellite pictures that were showing the same shape as in the very violent storm that hit the Netherlands on the 27 November I think it was in 1982 and also there were ship reports in the Gulf of Biscay that were reporting 70 knot winds already on Thursday afternoon.

P So if you had been on the air on R4 say in London forecasting for the whole of Britain on Thursday afternoon you would have been able to forecast that something very severe was going to happen?

DM Well that is always very hard to say and you should never tell those things after things have happened but certainly in our office and we are in a private office, Meteoconsult, we were watching the weather maps every hour and we were telling each other that something terrible is going to happen.

P I noticed that Francis Wilson on BBC Breakfast TV was able to say on Tuesday morning that he thought that certain severe weather was on its way and he gets his information largely from University College, London and from the same place, Harry that you get yours as well, the European Centre for Medium Range forecasting.

P Why was it David Houghton that these people at Reading seemed to be so much more accurate than you were at Berkshire.

DH I am sorry that I do not accept that anybody was more accurate than we were. I don't think any of us were in any position to predict the exact position of this storm or the exact timing of it lets face it only lasted for some four hours at any one place and it only covered a very limited area from Dorset up to Norfolk and southeast of that line.

P ...... repeated the comment that is was a limited storm.

DH That's right but nevertheless it was a fairly narrow track only about two or three hundred miles wide and when you look at the forecasts that were issued we predicted stormy weather as far back as Sunday.

P Harry are these lame excuses or do you as fellow meteorologist ...

DM Oh no I agree with the British Met Office that their models in those situations are normally much better that the European Centre and most of the time they do very accurate forecasts.

P But let's face it it is all a bit weedy is not if you forecasters can't tell us when the major things are going to happen you can only tell us when it is going to rain a little bit or be sunny a little bit but when we are going to have hurricane force gales you are mute.

DM Yes that's right but I think what you have to watch the weather maps very closely and one of the very big problems in the computer models in those days of Wednesday and Thursday was that there were a number of lows and that one of the lows should explode, that was clearly visible on all the meteorological maps, but it was almost impossible to say which one and at a certain point you have to leave the computer models and just use your brains.

P And do the Meteorological Office do this sufficiently in your view?

DM I don't know that I can't tell I can only say what happened on the weather maps and I guess that even within the Met Office there were different interpretations of what was happening.

P I think one thing that you have done this morning is that you have exploded a myth that everyone on the continent knew with tremendous precision what was going to happen and we in Britain were ignorant of it that is not the case?

DM I think that the Met Office was not ignorant of what could happen because as a matter of fact their numerical model which is very good and I appreciate looking at it every morning, they did have a low passing almost over the position in which it really was right?

P Just a few miles wrong mean't that it was over the land rather than over the sea.

DM Well no, it did take the low over the land, but what was happening also there were tremendous pressure falls when the low was coming in but at this point the low came over land and the pressure rises after the low passed were so huge I've never seen them be so huge over the southern part of England -- pressure rises of 23 mb in three hours and well that is a certain way to get a lot of wind especially in gusts.

P One that you couldn't have forecast either?

DM Well probably not although we were aware that on Thursday afternoon that with the 70 knot winds in the Gulf of Biscay this was going to be a violent storm.

P Harry .. thank you for joining us this morning.

Annex 5.3 Article entitled 'MEGA-BLOOMER' on CEEFAX.

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     CEEFAX 701  Fri 30 Oct   14:28/42
                                  3/15
                       PAPER ROUND
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P 701  CEEFAX 701  Fri 30 Oct   14:37/03
                                    2/15
                          THIS WEEK
  PAPER ROUND    Keith Hazelton
                 goes through his
                 postbag and answers
                 queries from amateur
                 editors.
  NEWS     * Stock markets seek
             computer scapegoats
           * $4 million computer theft
  MEGA-BLOOMER     With all the
                   computing power at
                   their disposal, how
                   did the weather men
                   get it so wrong?
  Reviews on 702
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P 701  CEEFAX 701  Fri 30 Oct   14:41/26
                                    10/15
                          MEGA-BLOOMER
  Weather persons are at a loss to
  explain the failure of all their
  very expensive equipment to warn
  them of last week's storms.
  The gales which uprooted trees and
  demolished houses all over south-
  east England were the worst for
  285 years.
  The Met Office computer, however,
  was blithely predicting light
  showers, bright intervals and
  moderate winds...
  Based in Bracknell, Berkshire, the
  machine is a Control Data Cyber 205
  capable of 400 million operations
  a second - not that it helped.
P 701  CEEFAX 701  Fri 30 Oct   14:42/03
                                    11/15
                          MEGA-BLOOMER
  If your car was squashed by a tree
  during last week's gales you may be
  a little peeved to hear that the
  number cruncher at the Met Office
  had no idea what was going on.
  The Cyber 205 is supposedly capable
  of producing a 24-hour world
  weather forecast at 15 altitude
  levels in less than five minutes.
  Data comes from satellites, radar,
  merchant ships and weather balloons
  It seems to have spotted the storms
  (so far so good) but sent them out
  into the North Sea...
 More
P 701  CEEFAX 701  Fri 30 Oct   14:42/38
                                    12/15
                          MEGA-BLOOMER
  The Cyber 205 which the Met Office
  uses to to calculate its weather
  forecasts (or not) is a vector
  processor.
  This means that it can perform
  operations over and over again very
  efficiently, providing it gets its
  instructions in the right order.
  An IBM 3081 has the job of
  controlling the flow of data.
  At the other end of the production
  line is a stream of 64-bit results
  making up a three-dimensional model
  of the atmosphere.
 More
P 701  CEEFAX 701  Fri 30 Oct   14:43/12
                                    13/15
                          MEGA-BLOOMER
  According to weather persons, the
  way to avoid embarrassing blunders
  like their failure to predict last
  week's storms is to supply their
  computers with more data.
  While the British system is among
  the most sophisticated in the world
  it still plots its weather models
  75 kilometres apart.
  The key is more and better weather
  stations and more satellites, to
  make a finer focus possible.
  Meanwhile, don't park your car
  under a tree.
 Reviews next
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Annex 5.4 Selection of press reports.

The Times, 17 October

FORECASTING THE WEATHERMEN

The best that can be said of Mr George Younger's committee of inquiry into the Meteorological Office is that it will do no lasting harm to an institution which, hurricane notwithstanding, ought to command national pride. His choice of a physicist, Professor Pearce of Reading, and a mathematician, the ubiquitous Professor Sir Peter Swinnerton Dyer, will at least ensure that there is a proper understanding of probability and the nature of forecasting. There should be no rush to judgement, which may be disappointing for those who want a scapegoat for their fallen oaks.

One may ask whether the exercise is really necessary. Because it is staffed by scientists with a professional interest in truth, and scientists moreover who are under pressure to pay their way in the world by selling accurate predictions, the Met Office surely needed little prodding to investigate last week's work. In addition there is the near certainty that Mr Younger's invigilators will, by concentrating on the hurriance forecast, miss the issues that do need to be asked of the Met Office. These begin with the question why this organization should be part of the Ministry of Defence and not in the civilian sector, where it arguably belongs.

The retributive mood which reigned in some quarters last weekend has now dissipated, but it leaves an unpleasant trace. Scapegoating the forecasters for destructive weather is mostly futile. Worse was to behave as if the natural environment could be, or indeed should be, risk-free.

This is an age when the nation has started to learn some home truths about the necessity of risk-taking in economic life. It ought also to have learnt some degree of calmness in the face of environmental risk. It should have been able to eschew the impracticality of those who assaulted the Met Office but did not stop to ask what difference a more accurately timed forecast would have made.

The Government might, in the circumstances. have stood up to the organization's voluble critics. Alternatively it might have, quite properly, decided that a full-scale inquiry into the Met Office was timely. Mr Younger's solution – a committee to monitor the conduct of the Met Office's own inquiry – is satisfactory on neither count.

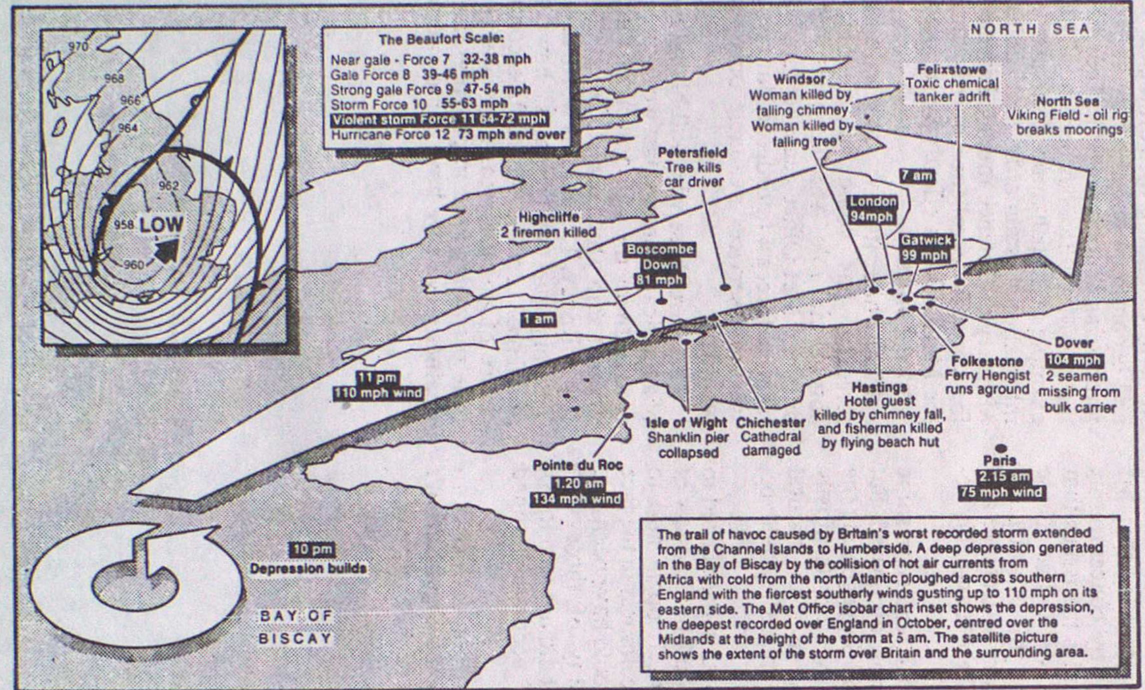
The Met Office is still being asked to do too much. Its functions are too widely spread. It juggles different, and sometimes conflicting, purposes. It needed the financial spur (applied since the late 1970s) that has forced it to provide more marketable information. But the relationship between its sale of forecasts (using a most complicated tariff which seems to penalize one set of commercial users, the airlines, against another, the shippers) and its public responsibilities bears reappraisal.

When the Public Accounts Committee examined the Met Office last year it focussed on maximizing revenues, treating the Office's work in extending meteorological knowledge and becoming a global centre of excellence in forecasting as a bonus. What has happened is that the Met Office has become an outstanding example of British applied science, working at international standards, but doing it with Ministry of Defence money. Instead of paying for scientific excellence openly and proudly, the Met Office is effectively supported by the Armed Forces.

Meanwhile, its civic role as a supplier of forecasts has come to conflict with its commercial role. At what point, for example, does the Met Office cease to supply a general farming forecast in order to put resources into specialist services available only for farmers who pay?

There are those who will blame the absence of a hurricane forecast last week on economies, among them the withdrawal of funds for the weather ship which used to be on station in the Bay of Biscay. The point is worth investigating. The big question remains, however, to be answered: can the Met. Office continue as a centre of global forecasting while at the same time providing (and improving) the domestic weather service we have come to expect?

The timetable of havoc in Britain's worst storm


970
968
966
964
962
958
LOW
960
The Beaufort Scale:
Near gale - Force 7 32-38 mph
Gale Force 8 39-46 mph
Strong gale Force 9 47-54 mph
Storm Force 10 55-63 mph
Violent storm Force 11 64-72 mph
Hurricane Force 12 73 mph and over
NORTH SEA
Windsor
Woman killed by falling chimney
Woman killed by falling tree
Felixstowe
Toxic chemical tanker adrift
North Sea
Viking Field - oil rig breaks moorings
Petersfield
Tree kills car driver
7 am
London
94mph
Gatwick
99 mph
Highcliffe
2 firemen killed
Boscombe Down
81 mph
1 am
Dover
104 mph
2 seamen missing from bulk carrier
Folkestone
Ferry Hengist runs aground
11 pm
110 mph wind
Hastings
Hotel guest killed by chimney fall, and fisherman killed by flying beach hut
Isle of Wight
Shanklin pier collapsed
Chichester
Cathedral damaged
Pointe du Roc
1.20 am
134 mph wind
Paris
2.15 am
75 mph wind
10 pm
Depression builds
BAY OF BISCAY

The trail of havoc caused by Britain's worst recorded storm extended from the Channel Islands to Humberside. A deep depression generated in the Bay of Biscay by the collision of hot air currents from Africa with cold from the north Atlantic ploughed across southern England with the fiercest southerly winds gusting up to 110 mph on its eastern side. The Met Office isobar chart inset shows the depression, the deepest recorded over England in October, centred over the Midlands at the height of the storm at 5 am. The satellite picture shows the extent of the storm over Britain and the surrounding area.

The most violent storm ever recorded in Britain was almost completely unpredicted in public weather forecasts, the Meteorological Office admitted yesterday. Had it struck in daylight, with many people out of doors, the consequences could have been disastrous (Robin Young writes).

The main evening forecast at 9.30 pm on Thursday predicted 30 mph winds, with gusts up to 50 mph. The midnight forecast on Radio 4 did warn of a risk of serious gales, but it was an hour before the Met Office alerted fire brigades and police forces to the danger of extreme winds.

A Meteorological Office spokesman said yesterday: "We had forecast the risk of very high winds at the end of the week as long ago as last Sunday, but we did fail to fill in the detail. The storm blew up over the Bay of Biscay and came in over the sea from an area where we have very very sparse weather information. We failed to realize the rapid way in which the depression was deepening.

By contrast, the French Meteorological Department had warned on Tuesday of winds up to 90 mph on Thursday night. Using information provided by the Reading-based European Centre for Medium Range Weather Forecasting, which was also supplied to the UK Met Office, the French scientists asked radio stations to put out warnings on Tuesday. M Georges Dhonneur, a scientist at the department, said that he was convinced the warnings had helped France to escape the storms with few fatalities, although winds of 134 mph were recorded in Normandy. Dutch television viewers were warned on Wednesday night of freak storms hitting the English south coast two days later.

The Reading computer warning was disregarded because it was later contradicted by the British Meteorological Office computer at Bracknell, which predicted at noon on Thursday that the depression would centre over northern France. "Usually later information is more accurate but in this case it was not", said a rueful forecaster last night.

The cause of the storm was a collision between a belt of very warm humid air drawn up from the west of Africa and cold Arctic air drawn down over the Atlantic. The resultant depression, the deepest recorded in Britain, deepened rapidly, passing west of the Brest peninsula and the Channel Islands before centring over England in the small hours of the morning.

The strongest winds were the southerlies and south-westerlies blowing at the centre of the storm as it travelled from Devon to Humberside. Gusts of more than 100 miles per hour were recorded in the Isle of Wight and along the South Coast, and of 110 mph in Guernsey. In London the wind gusted up to 94 mph, the highest since records began in 1940. The fiercest gust at Heathrow reached 93 mph, 30 mph faster than anything previously recorded there. The highest mean speed recorded was at Manston in Kent, where over ten minutes the wind averaged 69 mph, only 4 mph short of the speed for an officially designated hurricane on the Beaufort scale.

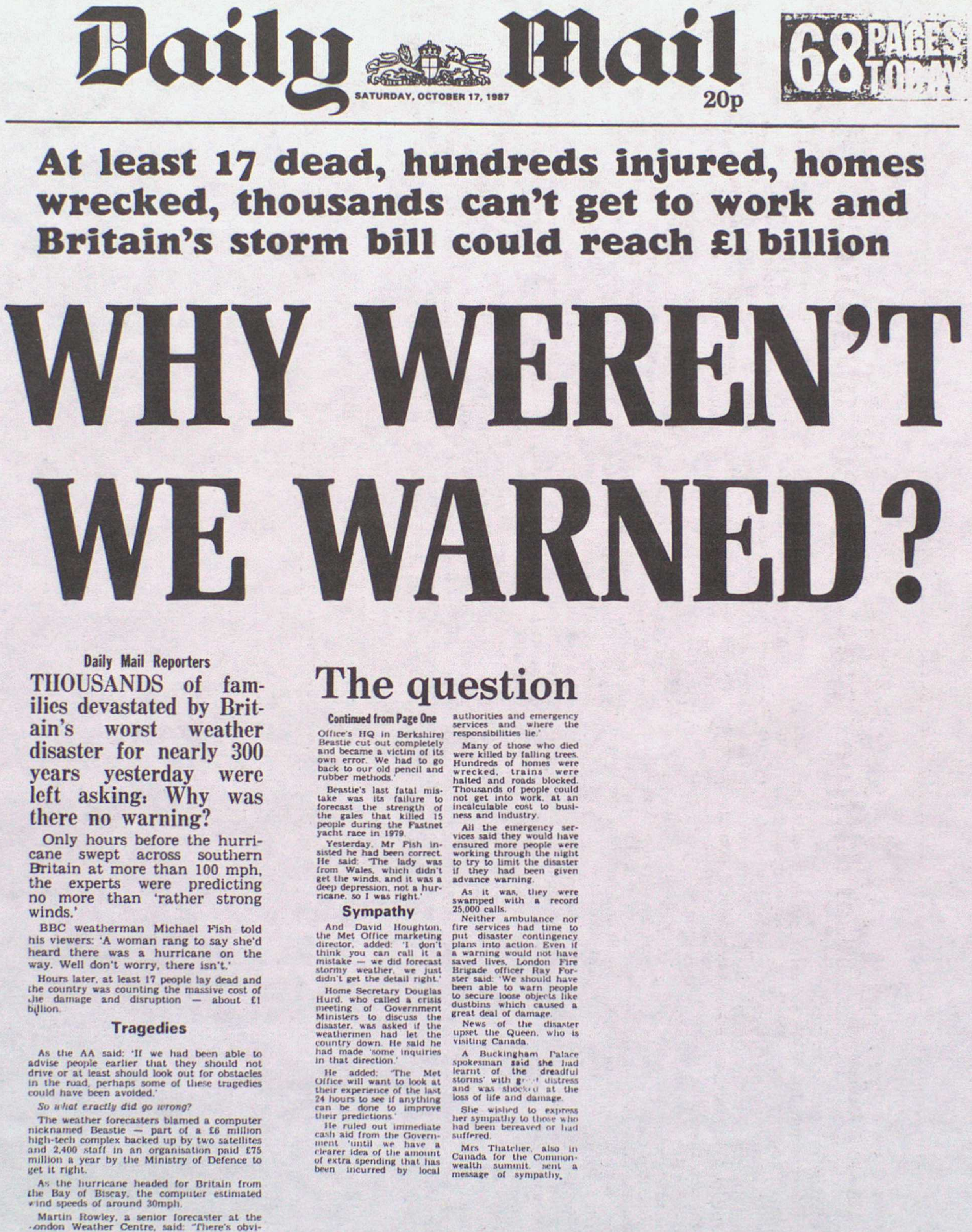
● The failure by weather forecasting authorities to give adequate warnings of the storm could make them liable for damages claims, a leading disaster claims lawyer said last night (Frances Gibb writes).

Mr Rodger Pannone, who advised families in the Zeebrugge disaster and the Manchester air crash, said that such claims would be breaking new ground. However, a claim might be possible if people who were injured, or whose relatives had died, were able to show that the weather forecasters had known of the impending storm and that they had failed to give adequate warnings, breaching a duty of care.

Mr Pannone said that whether there was a duty of care or not would have to be tested in the courts.

● Britain's worst gale was the great Channel storm of November 26 and 27, 1703, which ravaged southern England and was estimated to have killed about 8,000 people. Thousands of tons of shipping were lost and the first Eddystone lighthouse was destroyed.

Daily Mail, 17 October



Daily Mail
SATURDAY, OCTOBER 17, 1987
20p
68 PAGES TODAY

At least 17 dead, hundreds injured, homes wrecked, thousands can't get to work and Britain's storm bill could reach £1 billion

WHY WEREN'T WE WARNED?

Daily Mail Reporters

THOUSANDS of families devastated by Britain's worst weather disaster for nearly 300 years yesterday were left asking: Why was there no warning?

Only hours before the hurricane swept across southern Britain at more than 100 mph, the experts were predicting no more than 'rather strong winds.'

BBC weatherman Michael Fish told his viewers: 'A woman rang to say she'd heard there was a hurricane on the way. Well don't worry, there isn't.'

Hours later, at least 17 people lay dead and the country was counting the massive cost of the damage and disruption — about £1 billion.

Tragedies

As the AA said: 'If we had been able to advise people earlier that they should not drive or at least should look out for obstacles in the road, perhaps some of these tragedies could have been avoided.'

So what exactly did go wrong?

The weather forecasters blamed a computer nicknamed Beastie — part of a £6 million high-tech complex backed up by two satellites and 2,400 staff in an organisation paid £75 million a year by the Ministry of Defence to get it right.

As the hurricane headed for Britain from the Bay of Biscay, the computer estimated wind speeds of around 30mph.

Martin Rowley, a senior forecaster at the London Weather Centre, said: 'There's obviously a fault in Beastie's computer programme.

'When the storm hit Bracknell (the Met

The question

Continued from Page One

Office's HQ in Berkshire) Beastie cut out completely and became a victim of its own error. We had to go back to our old pencil and rubber methods.'

Beastie's last fatal mistake was its failure to forecast the strength of the gales that killed 15 people during the Fastnet yacht race in 1979.

Yesterday, Mr Fish insisted he had been correct. He said: 'The lady was from Wales, which didn't get the winds, and it was a deep depression, not a hurricane, so I was right.'

Sympathy

And David Houghton, the Met Office marketing director, added: 'I don't think you can call it a mistake — we did forecast stormy weather, we just didn't get the detail right.'

Home Secretary Douglas Hurd, who called a crisis meeting of Government Ministers to discuss the disaster, was asked if the weathermen had let the country down. He said he had made 'some inquiries in that direction.'

He added: 'The Met Office will want to look at their experience of the last 24 hours to see if anything can be done to improve their predictions.'

He ruled out immediate cash aid from the Government 'until we have a clearer idea of the amount of extra spending that has been incurred by local authorities and emergency services and where the responsibilities lie.'

Many of those who died were killed by falling trees. Hundreds of homes were wrecked, trains were halted and roads blocked. Thousands of people could not get into work, at an incalculable cost to business and industry.

All the emergency services said they would have ensured more people were working through the night to try to limit the disaster if they had been given advance warning.

As it was, they were swamped with a record 25,000 calls.

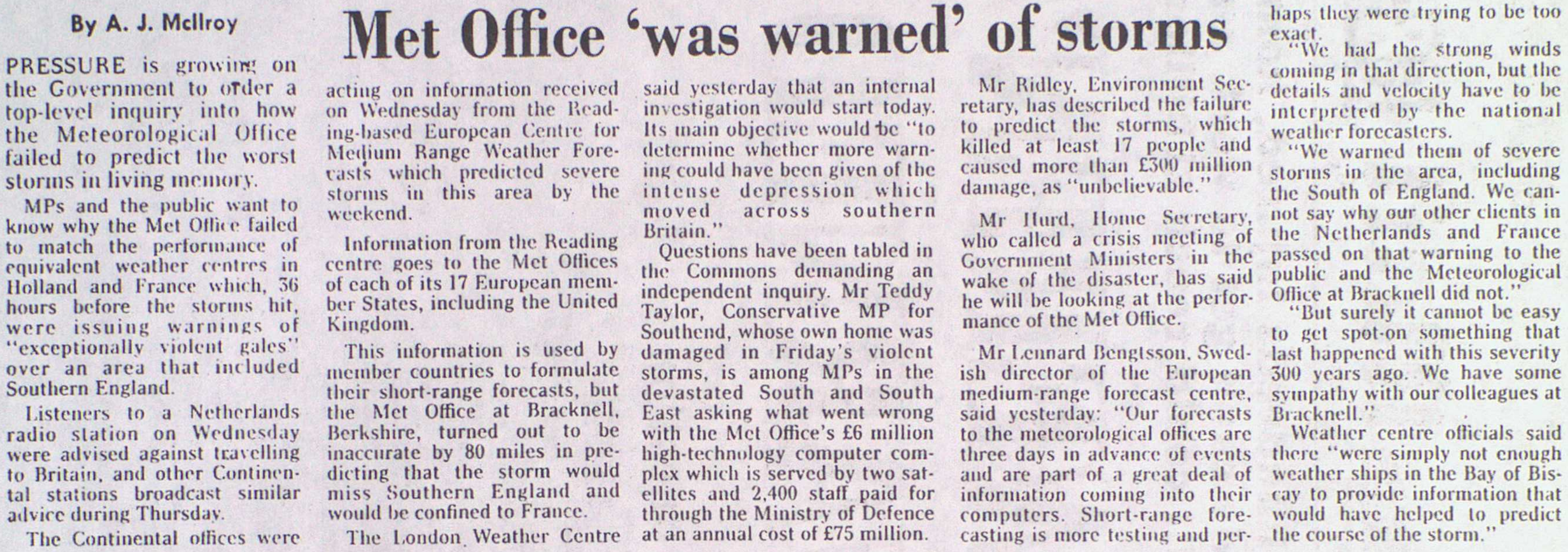
Neither ambulance nor fire services had time to put disaster contingency plans into action. Even if a warning would not have saved lives, London Fire Brigade officer Ray Forster said: 'We should have been able to warn people to secure loose objects like dustbins which caused a great deal of damage.

News of the disaster upset the Queen, who is visiting Canada.

A Buckingham Palace spokesman said she had learnt of the dreadful storms' with great distress and was shocked at the loss of life and damage.

She wished to express her sympathy to those who had been bereaved or had suffered.

Mrs Thatcher, also in Canada for the Commonwealth summit, sent a message of sympathy.



Met Office 'was warned' of storms

By A. J. McIlroy

PRESSURE is growing on the Government to order a top-level inquiry into how the Meteorological Office failed to predict the worst storms in living memory.

MPs and the public want to know why the Met Office failed to match the performance of equivalent weather centres in Holland and France which, 36 hours before the storms hit, were issuing warnings of "exceptionally violent gales" over an area that included Southern England.

Listeners to a Netherlands radio station on Wednesday were advised against travelling to Britain, and other Continental stations broadcast similar advice during Thursday.

The Continental offices were acting on information received on Wednesday from the Reading-based European Centre for Medium Range Weather Forecasts which predicted severe storms in this area by the weekend.

Information from the Reading centre goes to the Met Offices of each of its 17 European member States, including the United Kingdom.

This information is used by member countries to formulate their short-range forecasts, but the Met Office at Bracknell, Berkshire, turned out to be inaccurate by 80 miles in predicting that the storm would miss Southern England and would be confined to France.

The London Weather Centre said yesterday that an internal investigation would start today. Its main objective would be "to determine whether more warning could have been given of the intense depression which moved across southern Britain."

Questions have been tabled in the Commons demanding an independent inquiry. Mr Teddy Taylor, Conservative MP for Southend, whose own home was damaged in Friday's violent storms, is among MPs in the devastated South and South East asking what went wrong with the Met Office's £6 million high-technology computer complex which is served by two satellites and 2,400 staff paid for through the Ministry of Defence at an annual cost of £75 million.

Mr Ridley, Environment Secretary, has described the failure to predict the storms, which killed at least 17 people and caused more than £300 million damage, as "unbelievable."

Mr Hurd, Home Secretary, who called a crisis meeting of Government Ministers in the wake of the disaster, has said he will be looking at the performance of the Met Office.

Mr Lennard Bengtsson, Swedish director of the European medium-range forecast centre, said yesterday: "Our forecasts to the meteorological offices are three days in advance of events and are part of a great deal of information coming into their computers. Short-range forecasting is more testing and perhaps they were trying to be too exact.

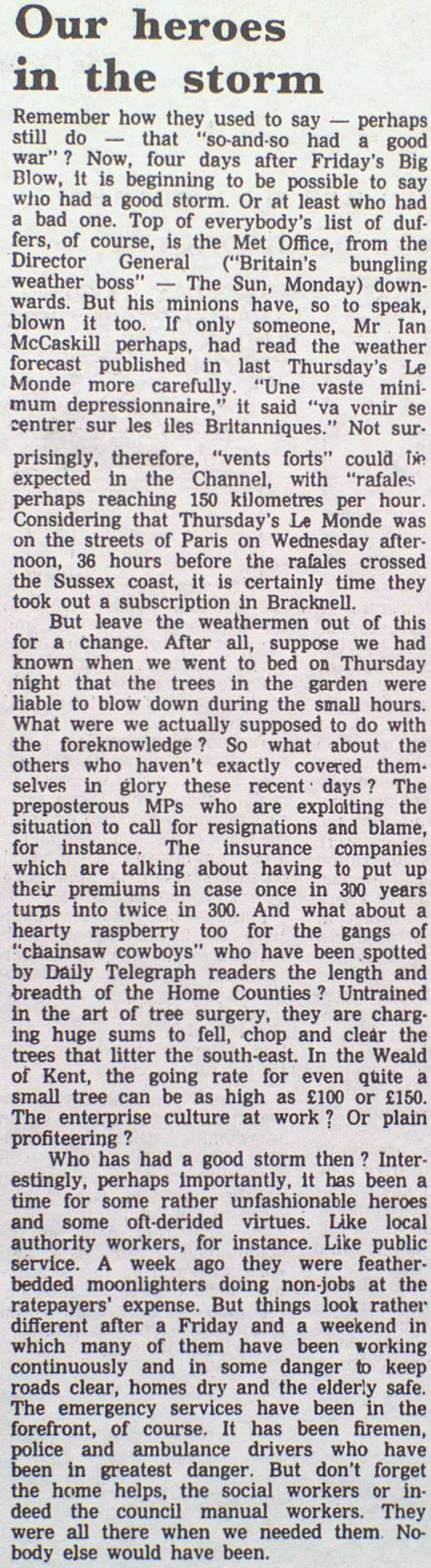
"We had the strong winds coming in that direction, but the details and velocity have to be interpreted by the national weather forecasters.

"We warned them of severe storms in the area, including the South of England. We cannot say why our other clients in the Netherlands and France passed on that warning to the public and the Meteorological Office at Bracknell did not."

"But surely it cannot be easy to get spot-on something that last happened with this severity 300 years ago. We have some sympathy with our colleagues at Bracknell."

Weather centre officials said there "were simply not enough weather ships in the Bay of Biscay to provide information that would have helped to predict the course of the storm."

Daily Telegraph, 19 October



Our heroes in the storm

The Guardian, 20 October

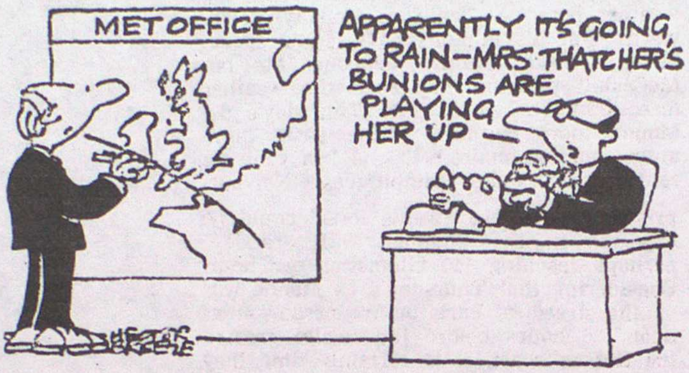
Remember how they used to say — perhaps still do — that "so-and-so had a good war"? Now, four days after Friday's Big Blow, it is beginning to be possible to say who had a good storm. Or at least who had a bad one. Top of everybody's list of duffers, of course, is the Met Office, from the Director General ("Britain's bungling weather boss" — The Sun, Monday) downwards. But his minions have, so to speak, blown it too. If only someone, Mr Ian McCaskill perhaps, had read the weather forecast published in last Thursday's Le Monde more carefully. "Une vaste minimum depressionnaire," it said "va venir se centrer sur les iles Britanniques." Not surprisingly, therefore, "vents forts" could be expected in the Channel, with "rafales" perhaps reaching 150 kilometres per hour. Considering that Thursday's Le Monde was on the streets of Paris on Wednesday afternoon, 36 hours before the rafales crossed the Sussex coast, it is certainly time they took out a subscription in Bracknell.

But leave the weathermen out of this for a change. After all, suppose we had known when we went to bed on Thursday night that the trees in the garden were liable to blow down during the small hours. What were we actually supposed to do with the foreknowledge? So what about the others who haven't exactly covered themselves in glory these recent days? The preposterous MPs who are exploiting the situation to call for resignations and blame, for instance. The insurance companies which are talking about having to put up their premiums in case once in 300 years turns into twice in 300. And what about a hearty raspberry too for the gangs of "chainsaw cowboys" who have been spotted by Daily Telegraph readers the length and breadth of the Home Counties? Untrained in the art of tree surgery, they are charging huge sums to fell, chop and clear the trees that litter the south-east. In the Weald of Kent, the going rate for even quite a small tree can be as high as £100 or £150. The enterprise culture at work? Or plain profiteering?

Who has had a good storm then? Interestingly, perhaps importantly, it has been a time for some rather unfashionable heroes and some oft-derided virtues. Like local authority workers, for instance. Like public service. A week ago they were featherbedded moonlighters doing non-jobs at the ratepayers' expense. But things look rather different after a Friday and a weekend in which many of them have been working continuously and in some danger to keep roads clear, homes dry and the elderly safe. The emergency services have been in the forefront, of course. It has been firemen, police and ambulance drivers who have been in greatest danger. But don't forget the home helps, the social workers or indeed the council manual workers. They were all there when we needed them. Nobody else would have been.

The Guardian, 21 October

When there are no weather ships in eye of the storm


MET OFFICE
APPARENTLY IT'S GOING TO RAIN—MRS THATCHER'S BUNIONS ARE PLAYING HER UP

Sir, — In its desperate attempt to find a scapegoat for the devastation caused by the recent storm, a section of the media has been baying for blood of the Meteorological Office.

While one must question whether a few hours' warning of the gales would have greatly reduced the extent of the damage, the fact remains that the forecasts for this period were not good. But this aberration should not blind us to the fact that the accuracy of the short-term forecasts is, on average, at least as good as that produced by any othe service in the world.

Part of the difficulty rests with the general level of scientific education and awareness in this country which forces the forecaster to say " it will " rather than to give alternatives with realistic probabilities for each.

Modern forecasts are based mostly on the output from computer models. No model can be better than the understanding of the atmosphere on which it is based, or than the data fed into it.

The primary sources of data are weather balloons launched every few hours from stations roughly 270km apart over Europe. In the Atlantic, there are just four weather ships to the north-west of the UK and none at all to the south-west where Thurday's storm formed.

These ships are being steadily withdrawn for financial reasons.

The abundant but less accurate data from weather satellites are scarcely adequate to replace these ships. So a forecast in which a 100km error in the track of a storm precipitates a national disaster, when based on such sparse data, must have a large element of chance.

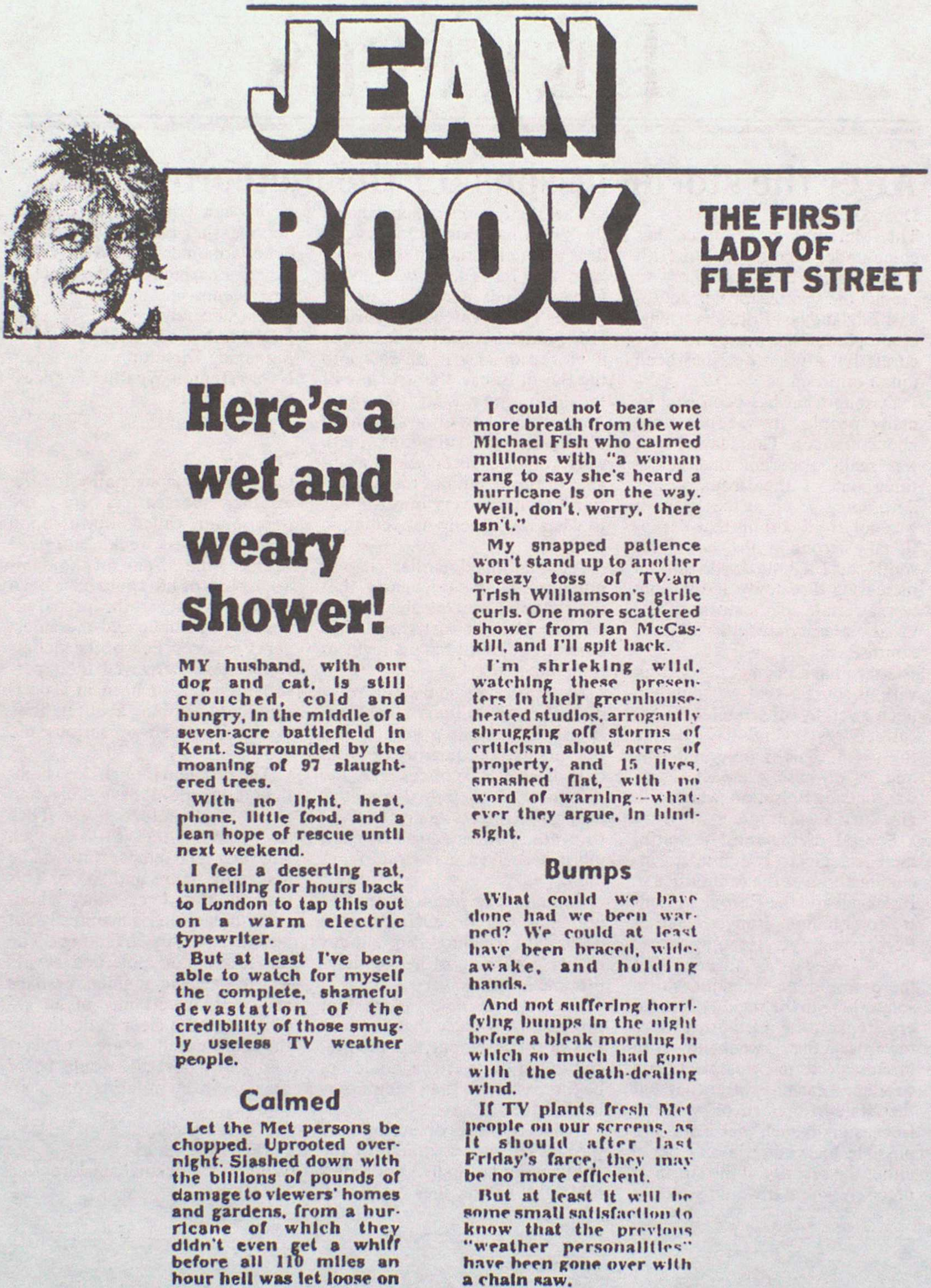
Better — but always probabilistic — forecasting of such extreme events will require better data and greater sophistication in its use.

(Prof) **B. J. Hoskins.**
(Dr) **I. N. James.**
Department of Meteorology.
University of Reading.

Sir, — I could have told the weather centre that a bad storm was coming because my barometer arrow had moved well beyond storm and was pointing at the name of the maker, Negretti and Zambra !

Perhaps from now on we could have fewer jokes and good wishes from the weather men and more serious forecasting. Men like Jack Scott would please me. — Yours faithfully,
(Mrs) **Irene Wilson.**
Chichester.

Daily Express, 21 October



JEAN ROOK

THE FIRST LADY OF FLEET STREET

Here's a wet and weary shower!

MY husband, with our dog and cat, is still crouched, cold and hungry, in the middle of a seven-acre battlefield in Kent. Surrounded by the moaning of 97 slaughtered trees.

With no light, heat, phone, little food, and a lean hope of rescue until next weekend.

I feel a deserting rat, tunnelling for hours back to London to tap this out on a warm electric typewriter.

But at least I've been able to watch for myself the complete, shameful devastation of the credibility of those smugly useless TV weather people.

Calmed

Let the Met persons be chopped. Uprooted overnight. Slashed down with the billions of pounds of damage to viewers' homes and gardens, from a hurricane of which they didn't even get a whiff before all 110 miles an hour hell was let loose on us.

I could not bear one more breath from the wet Michael Fish who calmed millions with "a woman rang to say she's heard a hurricane is on the way. Well, don't, worry, there isn't."

My snapped patience won't stand up to another breezy toss of TV-am Trish Williamson's girlie curls. One more scattered shower from Ian McCaskill, and I'll spit back.

I'm shrieking wild, watching these presenters in their greenhouse-heated studios, arrogantly shrugging off storms of criticism about acres of property, and 15 lives, smashed flat, with no word of warning—whatever they argue, in hindsight.

Bumps

What could we have done had we been warned? We could at least have been braced, wide-awake, and holding hands.

And not suffering horrifying bumps in the night before a bleak morning in which so much had gone with the death-dealing wind.

If TV plants fresh Met people on our screens, as it should after last Friday's farce, they may be no more efficient.

But at least it will be some small satisfaction to know that the previous "weather personalities" have been gone over with a chain saw.

The Independent, 21 October

LETTERS

After the storm: lessons for the meteorologists

Dear Sir,

The Meteorological Office has come under a great deal of criticism as a result of its failure to predict the severe storm in south-east England last Friday morning. Some of what has been said is accurate but a great deal has been unfair criticism.

Despite what has been said by many people, it was not until about 8pm on Thursday that it was really apparent that something out of the ordinary was developing. Even at that stage it was not at all certain that exceptionally strong winds would hit south-east England. It was only an increasing threat. By about 11pm it was certain that a storm of unusual severity would hit the South-East.

There have been reports from various sources that warning had been given by other meteorological services several days before the event. This is only half true and, in any case, the Met Office was one organisation which did give such a warning.

Several of the most powerful meteorological computers, including those at the Met Office in Bracknell and the European Centre for Medium Range Weather Forecasting at Reading, predicted five days in advance that there would be a major storm somewhere in the region of southern England or northern France towards the weekend. In broadscale terms, this prediction continued each day after that, but the state-of-the-art of weather forecasting is such that it was impossible to predict in any detail either the severity of the storm or precisely where it would strike.

The depression which caused the storm had existed for several days before it struck in south-east England. Indeed, it was giving force 11 winds north-east of the Azores two to three days earlier. However, during last Thursday, as it moved quickly north-east into the Bay of Biscay, the structure of the depression was far from clear. As Murphy's Law always seems to dictate in such situations, there were very few observations available in the vicinity of the depression and it was very uncertain as to what was exactly happening in Biscay.

As mentioned earlier, it was not until Thursday evening that the situation became clear and it became obvious that the South-east was going to have a night to remember.

Meteorology now uses the most powerful non-military computers in existence but the advances in the quality and quantity of input data have not kept up with the computer technology. No matter how good the computer and the software, it will not do a very good job if it is given inaccurate input data.

Summarising all the above, I do not think the Met Office can be criticised for failing to give a day or two's warning of a once-in-a-lifetime event.

The state-of-the-art of weather forecasting is such that the way this storm developed and the precise detail of its effects could not be forecast more than a few hours in advance.

What is more open to close scrutiny is why warnings to the public were not issued until after midnight. I think they could well have been issued three or four hours earlier but that is with the benefit of hindsight and it is really a question which only the Met Office can answer.

Yours sincerely,
NORMAN LYNAGH
Managing Director
Noble Denton Weather Services
London, EC1
19 October

Dear Sir,

One has some sympathy for the weather forecasters in the opprobium called down upon them after last week's storms. I suspect little, if any, of the damage or loss of life could have been avoided whatever the preparedness of the public and the emergency services. Few of the victims would have perceived their personal danger, or been in a position to do anything about it, however widespread or serious the warning.

The problem though does highlight a niggle I have long had about weather forecasters. They say invariably that it *will* do such and such. The temperature *will* be a specific figure and so on. This blandly stated certainty about something which is manifestly not becomes highly irritating. The public are not fools and always will respect the genuine, perhaps reasoned, uncertainty of an expert; indeed a clear indication of the considered degree of certainty of a forecast would be of great help in ordering one's affairs.

Yours faithfully,
PETER BENSON
Wingrave, Buckinghamshire
17 October

The Independent, 22 October

Taking stock in the wake of the hurricane

Dear Sir,

I was surprised at some of the press criticism of the Met Office for not predicting last week's hurricane, much of which went beyond the bounds of fair comment. The people who stand up in front of television cameras are only the front end of a very large operation, and the personal attacks on them were not warranted.

I was also surprised at the dead silence from the amateur brigade of frog-spawn watchers who usually claim to have said the right thing after the event.

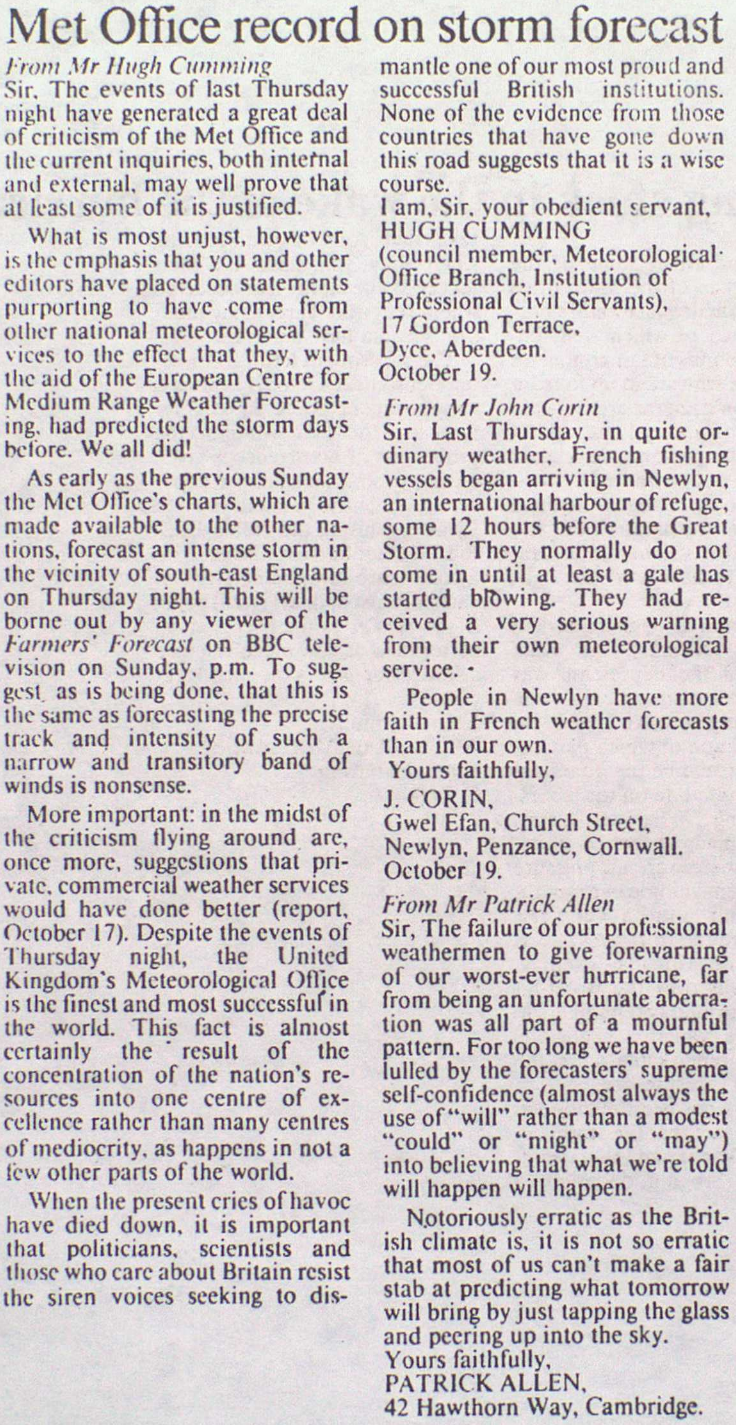
As Norman Lynagh remarked (letter, 21 October), the exact structure of the depression was very complex, with more than one centre being involved and no clear indication of which particular centre would be the dominant one until quite late on the Thursday evening. Whatever claims have been made by owners of barometers, there were no pressure falls of any magnitude over southern England until a very few hours before the storm. As late as 10pm on the Thursday evening, pressure falls over the worst-hit area were around two millibars in three hours, which is negligible. What *was* remarkable were the subsequent pressure rises.

What has not been mentioned at all is the fact that the storm occurred in October and that deciduous trees are not designed to take that sort of wind-loading when they still, have all their leaves. If the storm had occurred when trees were bare, many thousands would have survived.

The subsequent letter from Peter Benson (21 October) raises a very pertinent point. In weather forecasts for civil aviation, the probability of occurrence is given as, say, prob 20, meaning a 20 per cent probability. In the days when I was organising the Noble Denton Weather Service I insisted on a confidence level being given to each forecast and this is still being done. This gives the user a much better idea of how much reliance a forecaster places on each forecast.

Yours faithfully,
ARTHUR BLACKHAM
Alton, Hampshire
21 October

The Times, 23 October



Met Office record on storm forecast

From Mr Hugh Cumming

Sir, The events of last Thursday night have generated a great deal of criticism of the Met Office and the current inquiries, both internal and external, may well prove that at least some of it is justified.

What is most unjust, however, is the emphasis that you and other editors have placed on statements purporting to have come from other national meteorological services to the effect that they, with the aid of the European Centre for Medium Range Weather Forecasting, had predicted the storm days before. We all did!

As early as the previous Sunday the Met Office's charts, which are made available to the other nations, forecast an intense storm in the vicinity of south-east England on Thursday night. This will be borne out by any viewer of the *Farmers' Forecast* on BBC television on Sunday, p.m. To suggest, as is being done, that this is the same as forecasting the precise track and intensity of such a narrow and transitory band of winds is nonsense.

More important: in the midst of the criticism flying around are, once more, suggestions that private, commercial weather services would have done better (report, October 17). Despite the events of Thursday night, the United Kingdom's Meteorological Office is the finest and most successful in the world. This fact is almost certainly the result of the concentration of the nation's resources into one centre of excellence rather than many centres of mediocrity, as happens in not a few other parts of the world.

When the present cries of havoc have died down, it is important that politicians, scientists and those who care about Britain resist the siren voices seeking to dismantle one of our most proud and successful British institutions. None of the evidence from those countries that have gone down this road suggests that it is a wise course.

I am, Sir, your obedient servant,
HUGH CUMMING
(council member, Meteorological Office Branch, Institution of Professional Civil Servants),
17 Gordon Terrace,
Dyce, Aberdeen.
October 19.

From Mr John Corin

Sir, Last Thursday, in quite ordinary weather, French fishing vessels began arriving in Newlyn, an international harbour of refuge, some 12 hours before the Great Storm. They normally do not come in until at least a gale has started blowing. They had received a very serious warning from their own meteorological service.

People in Newlyn have more faith in French weather forecasts than in our own.

Yours faithfully,

J. CORIN,
Gwel Efan, Church Street,
Newlyn, Penzance, Cornwall.
October 19.

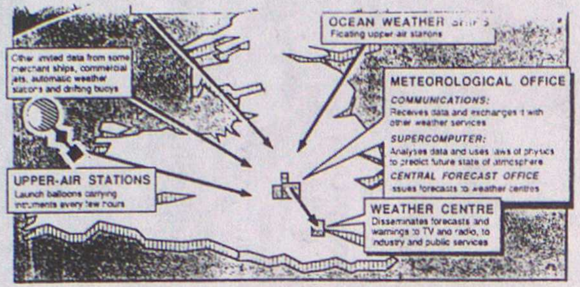
From Mr Patrick Allen

Sir, The failure of our professional weathermen to give forewarning of our worst-ever hurricane, far from being an unfortunate aberration was all part of a mournful pattern. For too long we have been lulled by the forecasters' supreme self-confidence (almost always the use of "will" rather than a modest "could" or "might" or "may") into believing that what we're told will happen will happen.

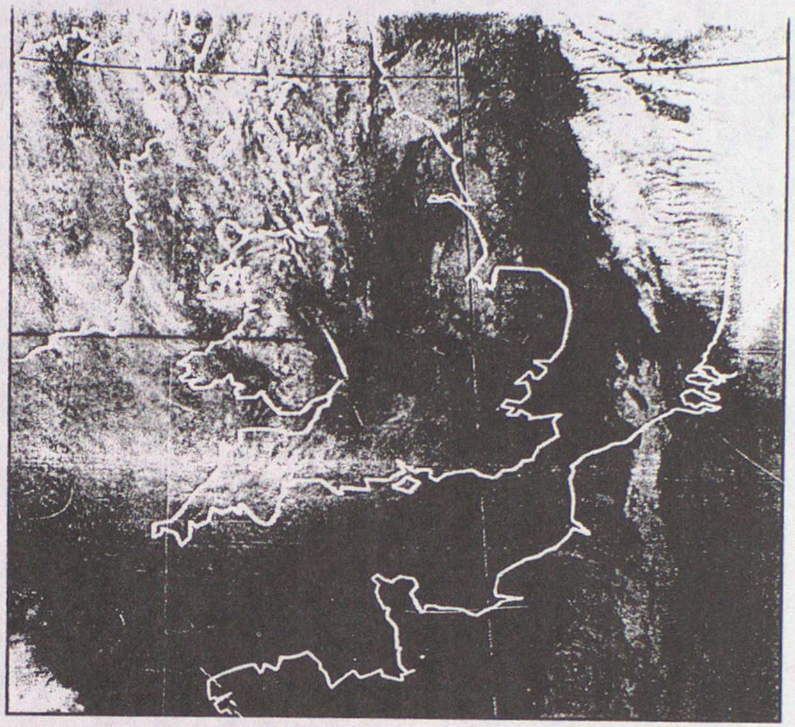
Notoriously erratic as the British climate is, it is not so erratic that most of us can't make a fair stab at predicting what tomorrow will bring by just tapping the glass and peering up into the sky.

Yours faithfully,
PATRICK ALLEN,
42 Hawthorn Way, Cambridge.

The Guardian, 31 October


OCEAN WEATHER SHIPS
Floating upper air stations
Other limited data from some merchant ships, commercial jets, automatic weather stations and drifting buoys
METEOROLOGICAL OFFICE
COMMUNICATIONS:
Receives data and exchanges it with other weather services
SUPERCOMPUTER:
Analyses data and uses laws of physics to predict future state of atmosphere
CENTRAL FORECAST OFFICE
Issues forecasts to weather centres
UPPER-AIR STATIONS
Launch balloons carrying instruments every few hours
WEATHER CENTRE
Disseminates forecasts and warnings to TV and radio, to industry and public services

RIGHT: A satellite picture depicting the storm at its height at 05.42 BST on October 16. It is remarkable how little indication it gives of the severe conditions over Southern England. The intense rain of the evening is now over the North Sea, as shown by the bright region of cloud. Reproduced by permission of Dr P. Bayliss, University of Dundee.



Brian Hoskins and Ian James on the enigma at the heart of the erupting hurricane

Inside the weather bomb

THE STORM during the night of October 15-16 was a very unusual event that had devastating consequences in southern and eastern England. Such rapidly intensifying weather systems, referred to as bombs by American meteorologists, are notoriously difficult to forecast.

The Americans have for many years been trying to discover the secret of the President's Day Storm of February 18-19, 1979, which left a large area of their East Coast under a totally unforecast blanket of snow. The Fastnet yacht race in the summer of 1979 was battered by a similar unexpected storm which left Ted Heath and many others struggling for their lives.

The latest example moved from the Bay of Biscay and deepened rapidly off the south coast of England before sweeping across England and out into the North Sea. Had it occurred later in the year, when the trees would have been leafless, much less damage would have been caused. If its path had been more northerly, it would have been less devastating: in the North-west of Scotland, such winds are less remarkable.

It is too early to judge the relative merits of various forecasts of the event, though it is clear that the short term forecast issued by the Meteorological Office was a serious understatement. There were some early indications of an extreme event which disappeared as the time came closer. Indeed, right up to the time the storm struck, forecasters were receiving contradictory guidance from their various models.

Thirty years ago, the production of a weather forecast involved a group of people marking information from weather observing stations around the northern hemisphere on a map and drawing lines of constant pressure, weather fronts, and so on. Relying on their experience, plus a number of rules of thumb — some of which have a scientific basis — they discussed the likely progression of the weather and produced their forecast.

Today, the process is very different. The first ingredient is still the observations which provide a global view of the current state of the atmosphere. For the purpose of the forecast, the upper air soundings, made by disposable packages of instruments carried up to heights of 12km or more by weather balloons, are most important. Other data are recorded by observers at sites on the earth's surface; measurements provided on a voluntary basis by some merchant ships and commercial aircraft. And, of course, there are the weather satellites.

The beautiful cloud images which now grace the TV forecasts are in fact less important than the measurements of temperature and cloud drift winds which can be made from the satellites. These satellite data are much less accurate, though more plentiful, than those taken during the conventional balloon ascents. They do not penetrate below the cloud tops. All these different measurements are passed to a local forecasting centre which then exchanges data with other centres via a world wide telecommunications system. Each centre receives some 100 million bits of information per day.

The data must then be analysed by complicated computer programs. These sift out obviously flawed readings before putting all the items of information together to generate a three-dimensional picture of the wind, temperature, pressure, and moisture in the atmosphere. Where no observations were taken, a reasonable guess, usually based on the previous forecast and the nearest available observation, has to be made.

This analysis of the atmosphere is then input to a second computer program which performs the forecast. Called the forecast model, this program is based on the laws of physics which govern the motion of the atmosphere, together with representations of processes such as rainfall, heating by the sun, and the mixing effect of eddies too small to include explicitly. It provides estimates of the future state of the atmosphere at successive times (typically at intervals of ten or twenty minutes) until the desired forecast time is reached.

In the UK, the forecast maps produced by the computer are inspected by the chief forecaster who decides on his interpretation of what the weather will be. The maps, accompanied by his firm guidance, are sent out to Weather Centres.' London Weather Centre issues national forecasts to the media. In particular, the TV weather presenter receives the information, and puts his own gloss on it.

However the hi tech image of satellites and computers sometimes obscures the reality of the situation. Satellite remote sensing of the atmosphere is an extremely important new source of information, but it remains secondary to more traditional data sources. For example, the Weather Ships in the Atlantic launch weather balloons and so provide local but very detailed and accurate information. Their reduction from eight to three for financial reasons can lead to a serious loss of information in some situations. The October 16 storm involved a quite small region of intense winds, some 300km across. Upper air stations are on average 270km apart in Europe, while the Weather Ships are much more widely dispersed. In these circumstances, it is no surprise that a storm can form over the ocean virtually unobserved.

Again, the fastest computers in the world are essential for running the forecast models. But it is these programs and especially the understanding of the workings of the atmosphere which they embody that is vital. The computer merely follows its instructions.

The TV weathermen have come in for a lot of unfair criticism in the present case. They are aware that they depart from the guidance issued to them from the Meteorological Office headquarters at their peril.

Rapidly developing bombs are the subject of much current research, including detailed observation experiments off the East Coast of North America where they are much more common. They seem to have a single cause; rather the processes which lead to ordinary mid-latitude depressions are more intense and co-operate more effectively in a bomb. A large local contrast in the temperature of the air is crucial, the very warm air of sub-tropical origin being laden with water vapour. A relatively warm sea surface — provided by the Bay of Biscay at this time of year — is helpful. The bomb usually seems to be detonated by a region of strong winds, or jet streak, high in the atmosphere moving over such a region. Unless such a jet streak is observed, no sophisticated computer is going to forecast the bomb correctly.

Any advance in our ability to predict extreme events must be based on improved understanding of the processes involved. This will lead to better use of the existing observational network, which must be protected from further decline. It will also lead to improvements in the forecast models. Perhaps the forecaster, who in recent years has tended to become a follower of the computer output, should begin to play a fuller part again.

For example, his judgment is crucial if two computer forecasts disagree about the development or movement of an event such as the recent storm. In such cases, the forecast can only be couched in terms of probabilities and the public must be scientifically sufficiently educated to accept this.

No one in the present situation could have said that the storm would definitely occur. But, if alternative forecasts could have been discussed, the possibility of the storm would almost certainly have been mentioned. Equally, they would also mention the possibility of disaster when nothing spectacular happens. However sophisticated the forecast system, the behaviour of the atmosphere will always have a large element of chance.

Professor Brian Hoskins and Dr Ian James are at the Department of Meteorology at Reading University

Annex 5.5 Radio and TV interviews with members of staff.

16 Oct	11.00 am	BBC Radio 2, Jimmy Young Programme	N Gait, LWC
16 Oct	11.00 am	BBC TV Open Air	M Fish, LWC
16 Oct	12.30 pm	ITN News	M Rowley, LWC
16 Oct	1.00 pm	BBC TV News	I McCaskill, LWC
16 Oct	5.30 pm	BBC Radio 1, Newsbeat	D Houghton, Met O 23
16 Oct	5.45 pm	ITN News	R Hunt, LWC
16 Oct	6.00 pm	BBC TV,Six O'Clock News	I McCaskill, LWC R File, LWC
16 Oct	10.00 pm	ITN News at Ten	M Morris, CFO R Hunt, LWC
16 Oct	10.30 pm	LWT, "The Great Storm"	R File, LWC
16 Oct	10.30 pm	BBC2 TV Newsnight	R File, LWC
19 Oct	10.00 pm	ITN News at Ten	Dr J Houghton
19 Oct	6.00 pm	TVS Coast to Coast	Anne Purvis (on secondment)
20 Oct	am	TV-AM	M Morris, CFO
20 Oct	9.10 am	BBC Radio 4, Tuesday Call	D Houghton, Met O 23
21 Oct	6.00 pm	Thames TV News	R Hunt, LWC
23 Oct	8.00 pm	BBC 2,Programme on the Storm	D Houghton, Met O 23

Annex 5.6 News Releases issued by the Press Office.

NEWS RELEASES ISSUED

Issued by Met O 23, Bracknell at 1500 on Friday, 16 October 1987 :

"The severe gales which affected south-eastern parts of the United Kingdom last night were probably among the worst in recorded history. The worst hit areas were southeast of a line from Dorset to Lincolnshire where gusts exceeded 100 mph in places causing extensive damage. The strongest gust recorded was 110 mph in Guernsey. Records were broken in many places. At Heathrow Airport for example a gust of 93 mph was recorded - this was 30 mph higher than anything recorded before there and has been estimated as likely to occur only once in five hundred years. Winds were close to hurricane force over the area, although the storm was not actually a hurricane.

The gales were caused by a depression moving up from Biscay across southern England and out into the North Sea. The strongest winds were on the eastern side of the path. As very warm moist air came into contact with colder air coming down from the north, the depression intensified to become the deepest probably ever recorded in this area in October.

The Met Office had been forecasting stormy wet weather for this period since the beginning of the week, but the exceptional nature of the gales was underestimated until a few hours before the storms struck. Warning messages were given to the Fire and Police services in many of the affected areas before the onset of the gales."

Issued by London Weather Centre at 1500 Saturday 17 October 1987 :

"The Central Forecast Office at Bracknell has sole responsibility for all Met. Office Public Service forecasts relating to weather in the United Kingdom. In particular, the national TV and Radio presenters who are employed by the Met. Office closely follow the guidelines issued from Bracknell. This was the case with the forecasts they issued on Thursday, 15 October 1987.

An internal enquiry concerning Friday's damaging winds is going ahead, the main objective being to determine whether more warning could have been given of the intense depression which moved across Southern Britain."

Annex 5.7 Report on the Press Conference held on 19 October 1987.

The Director General of the Meteorological Office, Professor John Houghton, gave a press conference at the London Weather Centre at 5.00 pm yesterday evening, as he put it "to set the record straight" about the forecasts of the storm on 16/17 October. Also with him were DS Met O, DR Met O and Sec Met O.

Professor Houghton explained that the storm had indeed been exceptional; a small depression in the Bay of Biscay had moved northeastwards to a position just south of Land's End, where it had slowed down and intensified rapidly. It then accelerated northeastwards over the country, turning north as it approached the North Sea. The highest winds were located to the south and east of the centre of the depression.

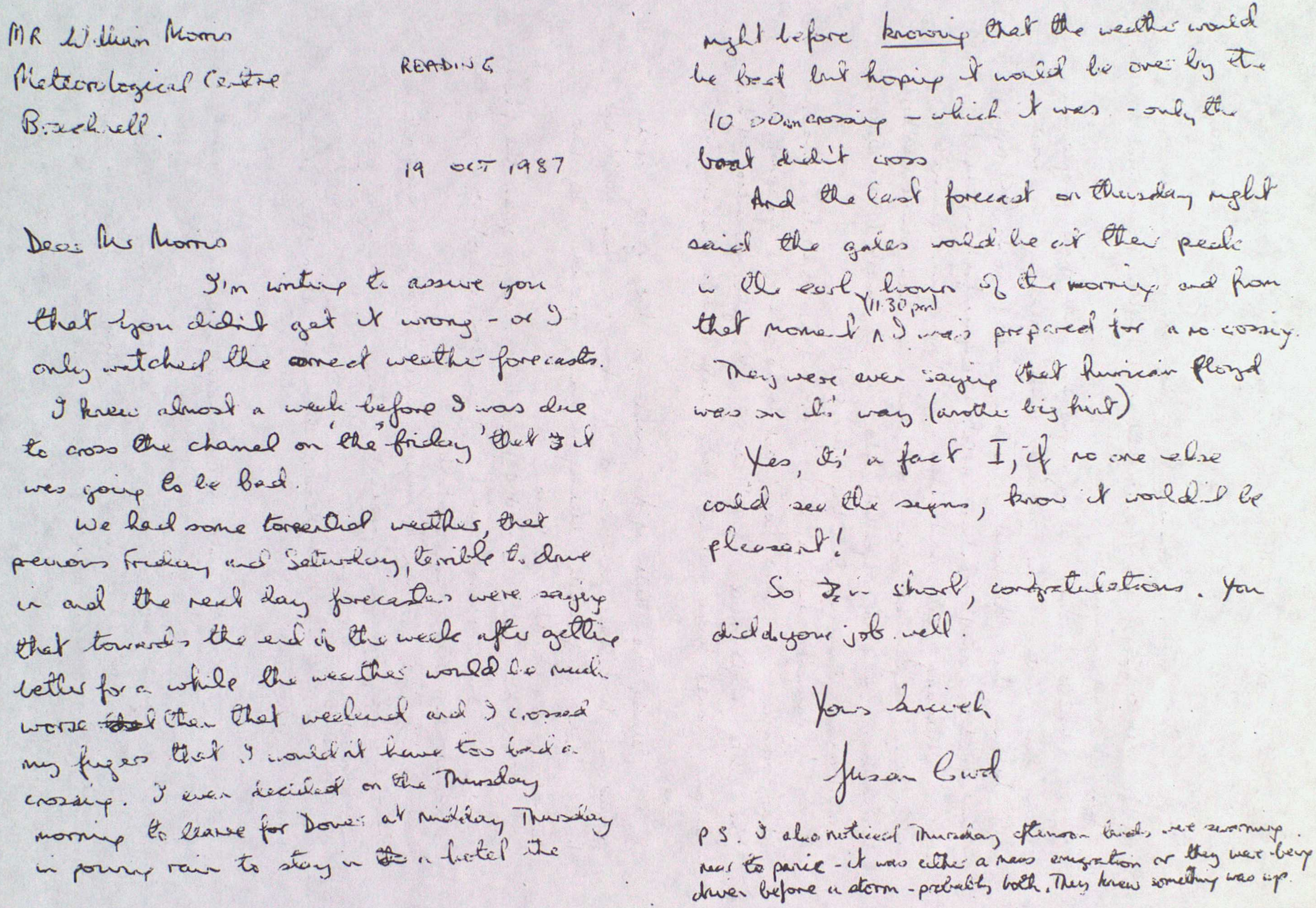
He showed a comparison between the actual track of the depression and the fine mesh forecast from 12Z 15 Oct 87 - copy enclosed. This showed that the track had been well forecast, but the slowing and deepening had not. He ascribed this to two key factors: firstly the sparseness of observational data in the Biscay area at the time, and secondly the small scale of the depression, which would have needed an even finer mesh than the existing model to resolve satisfactorily. He pointed out that none of the computer models, either in the UK or the continent, had predicted the details and severity of this development.

He defended the performance of the Office, pointing out that warnings had in fact been issued for sea and coastal areas. Gale warnings issued at 15.10 on Thursday showed southwesterly severe gale force 9 winds affecting all English Channel sea areas. He stated that an initial investigation, taking into account all the available information at the time, had not found fault with the forecaster involved.

To questions from the floor, Professor Houghton denied that other meteorological services had had any better warning. Like us, they had predicted very strong winds over the Channel and North Sea, but the severity of the winds inland had been underestimated. He conceded that the presence of a Weather Ship in the area might have provided information leading to a more accurate forecast of the development, but said that we were awaiting the introduction of new methods of observing the weather, such as satellite microwave techniques, which would provide much more comprehensive information. He also said that the introduction of the next supercomputer would allow even finer resolution models to be used, with an expected improvement in forecast accuracy for small scale features of this kind.

Outstations are advised to continue to divert any further press enquiries to the Press Office at Bracknell (Tel Bracknell (0344) 420242 Ext 2711)

Annex 5.8 Examples of letters received by the Meteorological Office from members of the public.



MR William Morris
Meteorological Centre
Bracknell.

READING

19 OCT 1987

Dear Mr Morris

I'm writing to assure you that you didn't get it wrong - or I only watched the correct weather forecasts.

I knew almost a week before I was due to cross the chanel on 'the friday' that it was going to be bad.

We had some torrential weather, that previous Friday and Saturday, terrible to drive in and the next day forecasters were saying that towards the end of the week after getting better for a while the weather would be much worse than that weekend and I crossed my fingers that I wouldn't have too bad a crossing. I even decided on the Thursday morning to leave for Dover at midday Thursday in pouring rain to stay in a hotel the night before knowing that the weather would be bad but hoping it would be over by the 10 00am crossing - which it was - only the boat didn't cross

And the last forecast on thursday night said the gales would be at their peak in the early hours of the morning and from that moment (11.30 pm) I was prepared for a no crossing.

They were even saying that hurricane Floyd was on it's way (another big hint)

Yes, it's a fact I, if no one else could see the signs, know it wouldn't be pleasant!

So in short, congratulations. You did your job well.

Yours sincerely

Susan Bird

P.S. I also noticed Thursday afternoon birds were swarming near to panic - it was either a mass emigration or they were being driven before a storm - probably both. They knew something was up.

S. YORKS

Chief Met Officer

Reference - Hurricane Winds 16TH Oct. 1987

Sir

I was so distressed at the media criticism aimed at the Met Office, Jim Mc. Caskill and Michael Fish that I feel I must comment.

Whilst I have every sympathy with those people who have lost relatives and suffered serious damage to property I believe that the harsh criticism aimed at the Met Office and certain staff members is totally ~~unjustified~~ unjustified.

Virtually all week reference had been given to a very deep depression that was forming and severe weather conditions could be expected later in the week (First reference on Farming forecast Sunday 11 Oct. 87)

I cannot believe that 100% of the population based their opinion on what turned out to be a rogue forecast on the late night news of 15TH Oct 87. A good percentage of these people would have retired long before this forecast was given

Surely the truth of the matter is that if 100% of the population had seen and heard the forecast they would not have acted differently bearing in mind previous life time severe gale conditions in Britain

In my view the Met Office have always given the general public a first class service of a science which is renowned as being unpredictable.

If the 'media knockers' were half as accurate in their everyday opinion forecasts then they may be justified in 'knocking' the others.

Until then, at least, let them stop their wingeing and witch hunting.

Peter & Elsie Leggitt

P.S. I have worked in Building & Civil Engineering contracts for 30+ years and have always relied on forecasts given by R.A.F. Met offices & weather stations during this period. Keep up the good service you have, at least, two supporters.

Kent.

18th October 1987

Dear Weathermen,

I feel I have to write and tell you how upset I have been by all the things that have been said about you since the storms of last Thursday night.

In my opinion you do a wonderful job and even when you do sometimes get it wrong how dull life would be if all your predictions were right!

I am sure there must be a great many people who feel as I do - you are lovely people and do not deserve all the rotten things that have been said about you. I also can't help thinking that had you been able to give a warning of what was to come it would only have served to make a lot of people panic and therefore there may well have been more people who would have died.

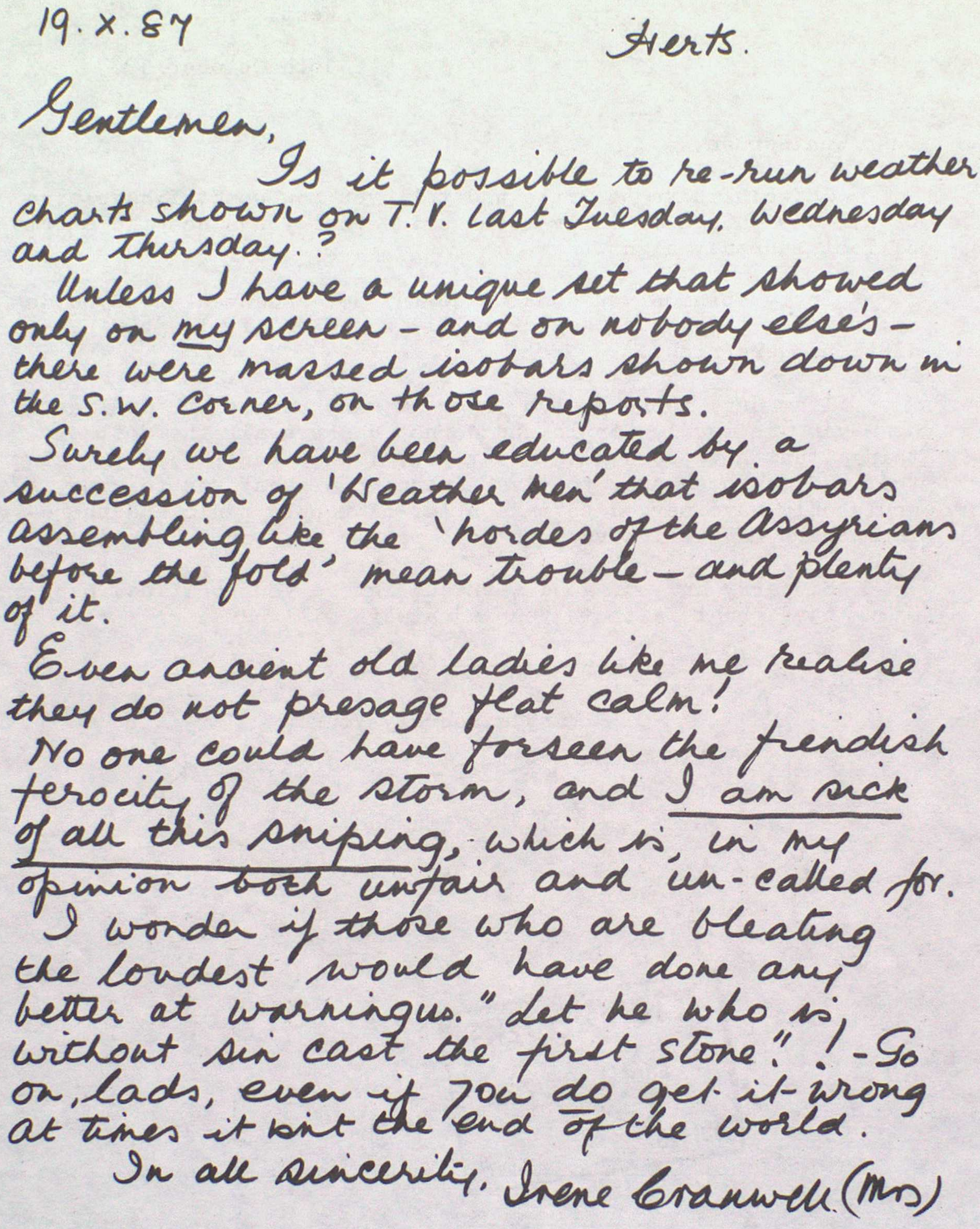
So carry on your good work and ignore your critics. Many of us have great faith in you and always will have.

With very best wishes to you all,

Very sincerely yours,

(Mrs) Nora Bingham.

BRACKNELL
20 OCT 1987
MET[illegible]AL OFFICE



19. X. 87

Herts.

Gentlemen,

Is it possible to re-run weather charts shown on T.V. last Tuesday, Wednesday and Thursday.?

Unless I have a unique set that showed only on *my* screen – and on nobody else's – there were massed isobars shown down in the S.W. corner, on those reports.

Surely we have been educated by a succession of 'Weather Men' that isobars assembling like the 'hordes of the Assyrians before the fold' mean trouble – and plenty of it.

Even ancient old ladies like me realise they do not presage flat calm!

No one could have forseen the fiendish ferocity of the storm, and *I am sick of all this sniping*, which is, in my opinion both unfair and un-called for.

I wonder if those who are bleating the loudest would have done any better at warnings." Let he who is, without sin cast the first stone"! - Go on, lads, even if you *do* get it wrong at times it isnt the end of the world.

In all sincerity. Irene Cranwell (Mrs)

16/3/3

TREAT OFFICIALLY
20 OCT 1987

Perth, Scotland

Dear Sir

The fiasco of inaccurate weather forecasting this week has been no surprise to any of my friends or myself, to whom the weather forecasts have been a joke for many months. We are all involved either in outside work (I am a soil sampler) or in outdoor pursuits and on countless occasions we have either been enjoying a day of continuous hot sunshine when the opposite has been predicted, or the reverse. Weekend forecasts have been equally unreliable — sometimes the content has been roughly correct, but the timing can easily be 24 hours out. I had intended to write to draw your attention to this ridiculous situation, considering the so-called technology available, but this is obviously the time to add my voice to the many.

Meanwhile, I shall still continue to put more faith in my book of old fashioned "weather lore"!

Yours truly

Pat Brown
(Mrs)

(4)

D. Illsley

Lancs.,

D. Illsley, B.Sc. Eng. (Hons.); C.Eng.; F.I.C.E.

Tel.

Chartered Civil Engineer

DI/RE

22nd October 1987

26/10

The Meteorological Office,
BRACKNELL.
Berkshire.

Dear Sir,

Storm on the 16th October 1987

I believe that your forecasting is being unfairly criticised. As a yachtsman I habitually listen to weather forecasts and am certain that adequate notice of impending trouble had been given.

On either the preceding Tuesday or Wednesday, your forecasts on the BBC Televison Programme were talking about a 200 m.p.h. jet stream stretching across the Atlantic and reaching the Iberian peninsula. On the same forecast a bulge was predicted to develop which would produce very strong winds sweeping up to the South of England at some later stage. The Television forecaster later commented that the storm would not reach England but would travel over France. Around this time a cyclonic wind system was shown over the channel and I noted this was the first occasion I had ever seen a storm predicted in this way.

On the 17.50 shipping forecast on Thursday 15th October 1987, a pressure of 768 mbs. was given for either Royal Sovereign or the Channel Light Vessel. It also stated that the pressure was falling very quickly. I turned to my travelling companion, who works at British Aerospace, and stated that the people in the South of England were going to suffer in a few hours time. He remembers this comment quite well.

You will no doubt be fully aware of the Operation Neptune system which operates in the North West of England. This system, which, of course, relies upon your weather forecasts, has worked superbly since its introduction and I am sure that you will find plenty of support in the North West from the North West Water Authority, the Police and the Local Authorities.

I suspect that the present brouhaha is the result of the usual kneejerk reaction of politicians. They tend to capitalise on anything which is of current public concern and hurt innocent parties in the process. Emotive descriptions such as "Hurricanes" are quickly pounced upon.

I wonder whether the real problem is one of communication breakdown and whether you have an integrated information system whereby your predictions are passed to the various Emergency Services. In any event, there is little that Emergency Services can do apart from being ready and advising people to stay at home.

It may be that "hurricanes" were too jocularly dismissed but if you had warned of such there could have been much panic. Should they not have materialised you would have lost out again.

Winds of 100 m.p.h. plus are not infrequent in North West Scotland and elicit no great todo.

You may use the above comments in any way you see fit and in closing I would like to thank you for the help which your forecasts have been to me, both in my job and as an amateur sailor.

Yours faithfully,

D. Illsley

D.ILLSLEY.

Chapter 6

CONCLUSIONS AND RECOMMENDATIONS

This chapter draws together conclusions from the preceeding chapters and also presents recommendations for action.

6.1 Analysis of the storm

Conclusions

6.1.1 Analyses of the storm, both the operational analyses at the time and subsequent 'aftercast' analyses, suffered from lack of observations in the vicinity of the storm while it was over the ocean. There were few ship reports at 0000 GMT 15 October 1987 in the area involved; analyses to the south-west of the United Kingdom depended on observations from Meteosat plus one ship. Analyses made at different times and in different ways differ significantly; none can be considered exact.

6.1.2 Although the low did not deepen 'explosively', the rise in pressure behind it *was* exceptional and the exact location of the band of very strong winds was unusual in being directed more than normal to the east and south of the centre of the low.

6.1.3 The statistics show that the 'gust to mean-wind ratio' was not exceptional, but that the existence of southerly/south-westerly winds and gusts of the reported magnitude was most exceptional overland in south-east England in October; there were return periods of over 100 years in places.

6.2 Forecast guidance

Conclusions

6.2.1 The guidance given by the UK Numerical Weather Prediction (NWP) model for the period of 3–6 days prior to the storm gave a good indication of the likelihood of a stormy period at the end of the week. In fact the guidance from the UK global NWP model was more consistent and accurate than that from either the ECMWF or the US NWP models. Forecasts from Sunday 11 October onward emphasized that a storm was expected to arrive on Thursday/Friday (15/16 October).

6.2.2 The NWP guidance 72–48 hours prior to the storm did not give a clear message in that the forecasters were left uncertain as to the likely track, timing and intensity of the low-pressure system. There were significant differences between the UK, ECMWF and US models.

6.2.3 Guidance derived from the analyses at 1200 GMT 14 October (36 hours prior to the storm reaching the United Kingdom) was not good from any of the NWP models. The UK model gave slightly better guidance than that from ECMWF, but at this time neither model developed the storm centre sufficiently or indicated the eventual strength of the winds over the inland parts of south and south-east England.

6.2.4 With regard to the forecasts from 0000 GMT 15 October, the UK 24-hour fine-mesh forecast and the 24-hour global coarse-mesh forecast differed substantially. Although the coarse-mesh model, in this case, gave a result which was closer to reality, the 24-hour fine-mesh forecast taken in conjunction with the previous 36-hour forecast and the following 12-hour fine-mesh forecast misled the Senior Forecaster by appearing to give a more consistent picture.

6.2.5 The Senior Forecaster's guidance was based on a compromise between the objective model guidance and his subjective experience. The Synoptic Reviews included the possibility of land gales for the exposed parts of southern and eastern England, but the emphasis was on the forecasting of rain and floods rather than on the wind.

Recommendation

6.2.6 Instructions to Senior Forecasters should emphasize that when a critical situation can develop in a number of ways, the consequences (in terms of emphasis on Warnings etc.) of the alternatives to the preferred solution must also be clearly stated in the Synoptic Reviews.

6.3 Scientific assessment

Conclusions

6.3.1 A study of the general synoptic situation at the time of the storm showed that the conditions strongly favoured cyclonic development. However, no features have been identified that would have enabled the quite exceptional character of the storm to be recognized at an early stage.

6.3.2 The observations available during 15 October left the actual position of the storm uncertain and fell far short of providing an adequate description of the atmospheric structure in its vicinity. The prerequisites for a really accurate prediction were therefore absent.

6.3.3 Using numerical forecasting systems already available in the Meteorological Office or at an advanced stage of development, it has been possible, by selecting values of the adjustable parameters, to obtain, beginning at 0000, 0600 and 1200 GMT on 15 October, good predictions of the track and intensity of the storm.

Recommendations

6.3.4 A continuing and enhanced effort should be made to improve the observational situation, especially in the Atlantic Ocean to the south and west of the United Kingdom. In particular it is necessary:

- To ensure the quality and early receipt of ships' observations;
- To increase the number of accurate aircraft wind observations;
- To consider the advisability of deploying additional observation platforms (e.g. drifting buoys) in the area to the south-west of the United Kingdom;
- To develop techniques for interpreting and using satellite data in NWP models;
- To introduce satellite-borne microwave sounders, observations from which can provide data on atmospheric structure under cloud conditions.

6.3.5 Further work should be carried out:

- To determine optimum parameters for the various Meteorological Office models, bearing in mind the particular time-ranges and purposes for which they are used;
- To introduce higher-resolution models at an early time and, especially, to press ahead with developments aimed at making the mesoscale model fully operational for a larger area;
- To complete testing of the analysis correction assimilation scheme with a view to its replacing the existing scheme within the next few months.

6.3.6 In view of the non-synoptic observations that are now available from aircraft and satellites, the fine-mesh model forecasts should be increased in frequency from two to four per day (for 0000, 0600, 1200 and 1800 GMT) as soon as possible.

6.4 Public forecasts and warnings

Conclusions

6.4.1 The Media forecasts on Thursday 15 October emphasized the rain predictions rather than the wind.

6.4.2 Gale and Severe Gale Warnings were issued for all affected sea areas in the morning (0630 GMT) of 15 October.

6.4.3 Warnings to other recipients during the evening of 15 October culminated in Flash Messages and warnings to appropriate authorities between 0120 and 0145 GMT 16 October.

6.4.4 Satisfactory warnings were sent to customers who had defined requirements for warnings above a given wind strength, so that they could take action quickly on receiving the warning.

6.4.5 No forecasts, known to us, by other countries referred to UK overland conditions. The UK forecasts for the Channel and over Europe were in general agreement with those of France, Belgium, and Holland.

Recommendations

6.4.6 A review should be made of the procedures concerning warnings of severe weather which are provided to emergency authorities. This review should address the appropriate threshold for the warnings, their dissemination and the actions which should be taken by the emergency authorities on receipt of the warnings. The review should address, in particular, in the light of experience of the 15/16 October storm (including consideration of what the situation would have been had the storm occurred at a different time of day), warnings of severe gales over land. The Meteorological Office should take action to initiate this review.

6.4.7 A review should be initiated of the meteorological content of TV presentations, in particular of the way in which the Senior Forecasters and media presenters select the emphasis that needs to be given to various factors in the time available.

6.4.8 There should be further discussions with the BBC about the 'style' of the TV presentations. While the more relaxed style of recent years provides a more entertaining product with increased attention from the general public, there may be a case for a specific 'slot' in which details of 'significant weather' (e.g. strong winds, ice, frost, snow, rain, fog) are given.

6.5 Media reaction

Conclusions

6.5.1 The Meteorological Office, hampered to some degree by failure of communications (all Bracknell telephone lines were down on the 16 October), failed to anticipate the reaction of the Media, in particular of the Press. Press articles, based on mistaken interpretation of remarks both in the United Kingdom and abroad, were highly critical because they thought 'other forecasting services' would have given earlier warnings.

6.5.2 A considered Meteorological Office response was not available until the Press Conference on Monday, 19 October. After this the tone was considerably changed for the better.

6.5.3 The close interrelation between the TV weathermen and the news teams means that they cannot avoid 'instant' reactions to extreme events such as this.

Recommendations

6.5.4 The Meteorological Office should make an internal review of its procedures for dealing with the Press and the Media.

6.5.5 A review should be made of the training provided for TV weathermen and official spokesmen in dealing with the Press and the Media.